JUNE 2007 VOL 15 NO 6

NSC

NEW STEEL CONSTRUCTION

www.new-steel-construction.com

Economical design for City tower
Teesside college starts regeneration
New vibration design guide
Steel aids climate change battle

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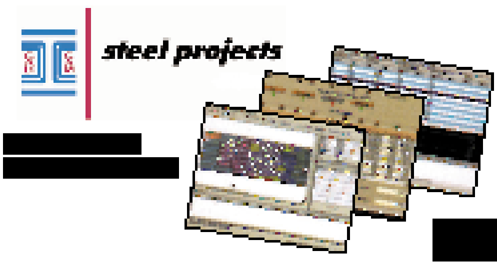

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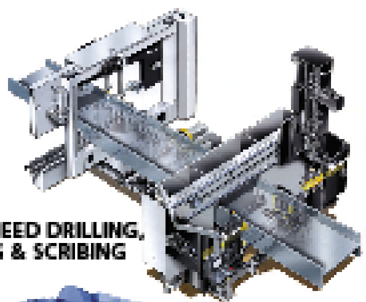

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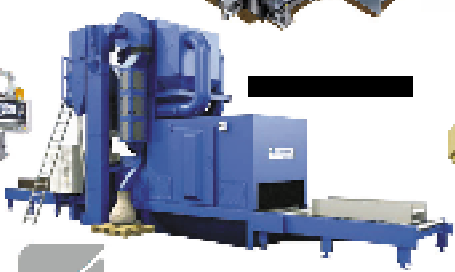

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Structural fire engineer: Buro Happold
Steelwork contractor: Severfield-Reeve

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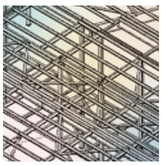
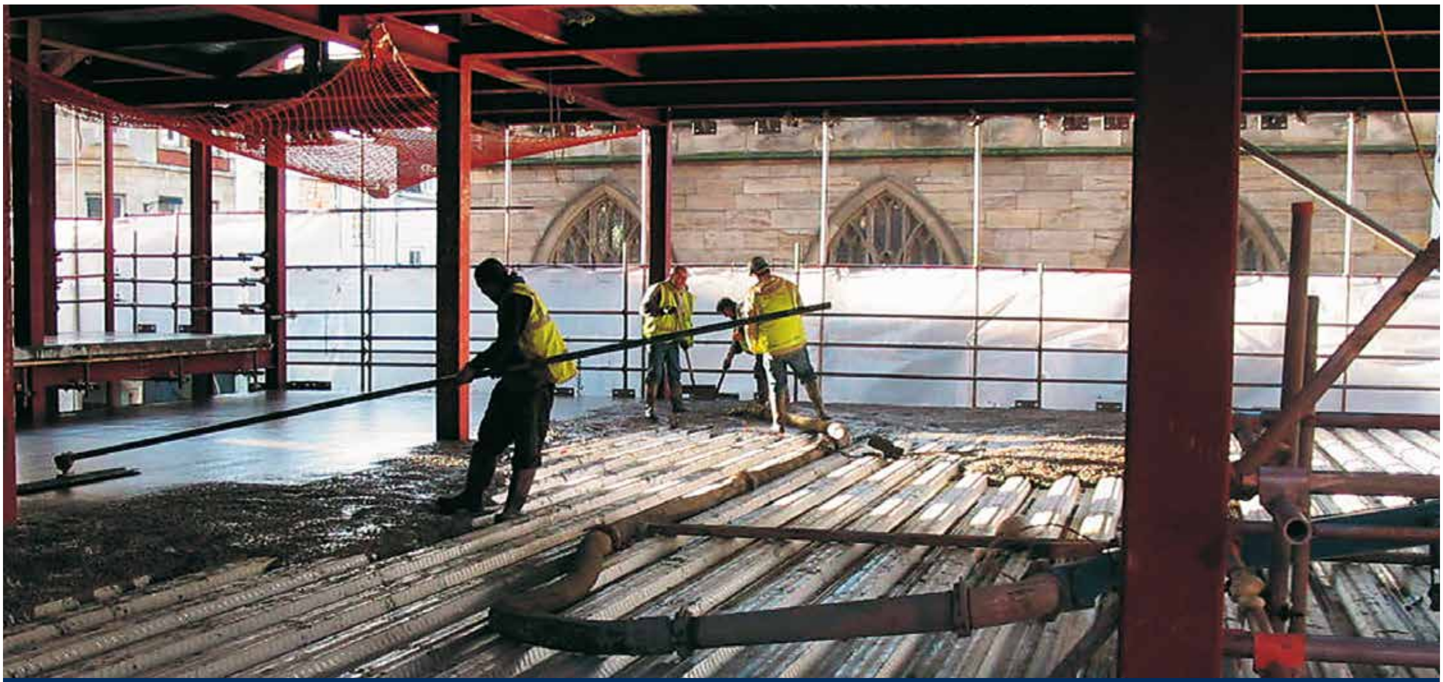
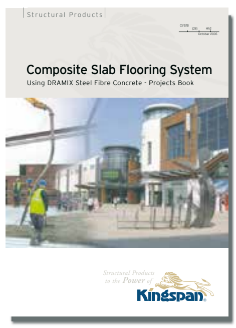


The British Constructional Steelwork Association Ltd





Structural Products
Composite Slab Flooring System
Using DRAMIX Steel Fibre Concrete - Projects Book
Kingspan

Sustainability is good business

Nick Barrett - Editor

The drive towards increasing sustainability of buildings was boosted recently by news from property developer British Land that it aims to become carbon neutral within two years. This has been hailed as the boldest sustainability move yet by a property developer. It is good news for the constructional steelwork sector that such a prominent client that often selects steel as a framing solution for its prestige developments has decided it can achieve this goal.

Obviously British Land has done its homework and concluded that steel frames offer the best chance of meeting its sustainability challenges; two of the company's current flagship schemes in the City, Broadgate Tower and the adjacent 201 Bishopsgate, have steel frames and are designed to exceed current Building Regulations energy use requirements by 29%.

Construction's clients are taking a lead, partly in response to consumer expectations, and they clearly expect their suppliers to at least keep pace with them. Anybody unsure of what pace will be required should look at Stanhope's list of ten core sustainability aims to be pursued for the next three years. The list, called Sustaining Good Business, has been circulated to all of Stanhope's construction suppliers and funding partners. Among the aims are improving building energy performance by at least 20% against the latest building regulations, reducing construction wastage 30% by volume, 15% of materials used in construction is to be of recycled origin, and 80% of construction waste is to be reused or recycled.

Progress towards many of these aims can be easily achieved by using steel frames for buildings. No other construction material can come close to steel for its reuse and recycling properties, as we highlight this month in the latest article in our sustainability series.

There seems little doubt that the client side of the construction industry has fully embraced sustainability – the targets being adopted now are not merely sketchily defined promises to do better, but are ambitious and, more to the point, measurable.

Developers are confident that all of this makes good business sense, that by exceeding minimum standards in areas like energy efficiency the value of their buildings will be enhanced. Building users are expected to be increasingly reluctant to rent or buy anything from a property company that will have an adverse impact on their own sustainability credentials.

Developers are expecting to have to pay more up front for the next generation of green buildings, perhaps up to 5% according to Stanhope, and there is no certainty that building users will be prepared to pay more for them – they may simply expect modern buildings to have high sustainability values as a base requirement. But there is expected to be a longer term pay back from increased value of the investment that these buildings represent.

New buildings only represent some 2% of the UK's buildings stock, and it will be a harder task to bring the other 98% into line with the best practice sustainability performances of new buildings. Retro fitting will be the answer for many buildings when they are being upgraded. Steel offers huge benefits to property owners when they want to modernise buildings because of the flexibility of steel framed structures. Buildings will usually have to be vacated of tenants while these works go on, and there is no doubt that the necessary works will be completed faster in a steel framed building, allowing tenants to get back in as soon as possible.

In short, the drive towards sustainability in buildings presents great opportunities for the constructional steelwork sector, as long as all parts of it take on board what the changing requirements demand of them and enthusiastically support initiatives like the BCSA's Sustainability Charter and other sustainability measures that are to come.

Industry speakers announced for Steel Day

The full list of speakers has been confirmed for the seminar programme at Steel Day which will take place at Old Billingsgate in London on 19 June.

The seminar schedule and speakers will consist of:

- Sustainable Steel Construction – Dr Michael Sansom, Manager Sustainability Group at SCI;
- Economic Design of Multi-Storey Buildings – Colin Smart, Corus Regional Technical Manager;
- Engineering for Fire - A Modern Approach – John Dowling, Corus Construction Development Manager;
- Innovations in Steel Construction – Neil Tilley, Corus Manager Construction Advisory Service;
- An Introduction to the Steel Eurocodes – Dr David Moore, BCSA Director of Engineering and Dr Roger Pope;
- A Review of the Steel Bridge Market – Chris Dolling, Corus Manager Construction.

Steel Day is being jointly hosted by Corus and the BCSA and will provide an opportunity for showcasing leading companies and their products and services.

The event includes an exhibition which will be open from 1.30pm. More than 40 exhibitors have reserved spaces including structural component manufacturers, software specialists, equipment producers and steelwork contractors.

Roger Steeper, Corus Manager Construction Marketing, said: "The event will highlight everything that is positive about the constructional steelwork sector and is not to be missed."

For more information and registration for this free event visit: *www.steelday07.com*

Bridging the missing link

The final £50M stage of the Leeds Inner Ring Road is under way and includes the construction of the dual two-lane 500m-long Hunslet Viaduct.

Known locally as 'the missing link' the Viaduct will connect the existing Ring Road with Junction 4 of the M621. Supported on concrete piers, the 12-span structure is being constructed with more than 2,000t of weathering steel.

The bridge features a distinctive S-shaped curve along its route over the previously industrial landscape of Hunslet.

The area was once the workshop of Leeds and for more than a century heavy engineering, including steel foundries, thrived in the area.

"The decision to use weathering steel was supported by the Council's planning department who liked the idea of reflecting the industrial heritage of Hunslet and the use of steel that looks like steel," said Derek Parody, Project Director for project designers Mouchel Parkman.

Steelwork contractor Fairfield-Mabey started erecting on site at the end of 2006 and is scheduled to complete its work - which also includes two smaller road bridges over the Leeds to Derby railway - by late August this year.

Fairfield's Project Manager, Ashley Cooper, said: "We initially erected one of the central spans as this was the optimum place to begin because of the fixed bearing. We've since completed the middle spans of the Viaduct leaving the two ends and abutments for completion this Summer."

Steel provides the answer for hospital car park

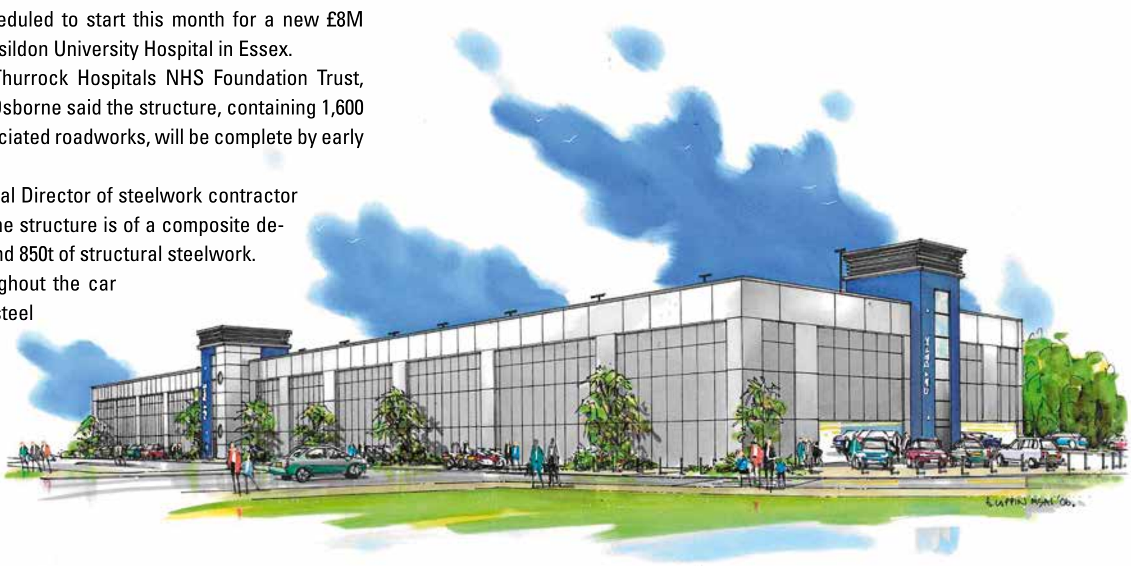
Steelwork erection is scheduled to start this month for a new £8M multi-storey car park at Basildon University Hospital in Essex.

Working on behalf of Thurrock Hospitals NHS Foundation Trust, main contractor Geoffrey Osborne said the structure, containing 1,600 spaces, along with all associated roadworks, will be complete by early 2008.

Robin Sharples, Technical Director of steelwork contractor SIAC Tetbury Steel, says the structure is of a composite design with pre-cast floors and 850t of structural steelwork.

"The grid pattern throughout the car park is 16m x 7.2m and all steel is galvanised," added Mr Sharples.

SIAC Tetbury will be erecting predominantly 305mm x 305mm UC's and 610mm x 305mm UB's throughout the car park.



BCSA guides promote safety

The BCSA's Codes of Practice guides are intended to give guidance on how to eliminate or reduce the risk of on-site accidents.

Peter Walker, BCSA Health and Safety Manager, said the publications highlight the contribution the BCSA is making towards a safer working environment.

"Statistical data provided by BCSA members show the steelwork industry is in line to achieve the accident reduction targets set by both the Health & Safety Executive (HSE) and the construction industry," he added.

All six publications carry an HSE endorsement and in part replace the withdrawn HSE publication GS 28 Safe Erection of Structures.

The full list consists of: Erection of Multi-Storey Buildings; The Erection of Low-Rise Buildings; The Metal Decking and Stud Welding; Windy Conditions Guide, Erection of Steel Bridges and Working at Height during Loading and Unloading of Vehicles.

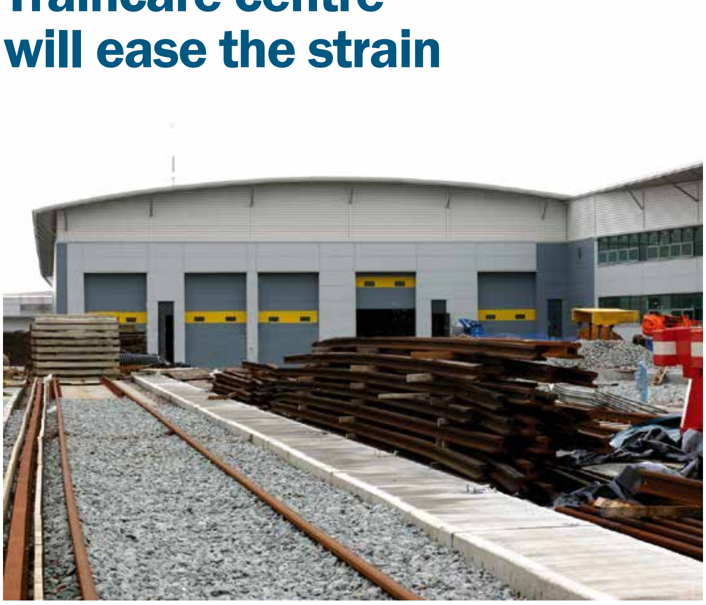
In conjunction with the Codes, Mr Walker said the BCSA has also developed the Safe Site Handover Certificate (SSHC) which is supported by the HSE as it provides a consistent approach to site safety.

The SSHC can be included in tenders by steelwork contractors and a free copy is available from the BCSA.

"To further highlight our safety credentials, we've also launched the Safety in Steel Construction (SiSC) which is a health and safety service available to our members and gives SME's access to a competent person, a 24-hour helpline and regular safety inspections," said Mr Walker.

The publications and information on SiSC are available from the BCSA, Tel: 0207 839 8566 or email: *postroom@steelconstruction.org.*

Traincare centre will ease the strain



Passengers using east Kent to London train services will soon benefit from a significant reduction in journey times on a new fleet of trains serviced and maintained at a new traincare centre.

The £40M state-of-the-art rail maintenance and servicing centre is under construction adjacent to Ashford International Station.

Conder Structures has supplied and erected more than 800t of steel for the project as part of its contract which it won from Fitzpatrick Contractors, part of the DEPCO consortium.

The facility, which is 185m-long x 38m wide, comprises a five-road, light maintenance centre and a connected two-storey office block. The structure is a two-span portal frame with a full-width curved roof, which has a valley line that follows the divide between the workshops and office.

Gordon Ridley, Conder Structures' Managing Director, said the entire steelwork was erected in only three and half weeks, beating the main contractor's programme.

"This was achieved by detailed design and full off-site checking at our factory before despatch, enabling the site team to proceed with the plan to minimise the erection time," he added.

Inside the facility Conder installed some complex steelwork for a suspended 2t gantry crane on the bogie change road, where carriages are lifted off for their running gear to be replaced.

The project is on schedule for hand-over in early July 2007.

Expansion programme complete at Elland Steel

A £3.1M investment and expansion programme, which commenced in August 2006, has recently been completed at Elland Steel Structures' Halifax facility.

Making use of an adjacent disused warehouse, Elland has moved much of its production into the additional 12,820m^2 space.

The scheme has also included the installation of new specialist equipment which has helped increase production capacity.

New equipment consists of a FICEP 1001 DZ CNC high-speed spindle drilling unit, close coupled with a plasma and oxy-fuel coping system. Both of these machines include the new labour-saving scribing technology.

Elland said its production line has been further enhanced by the installation of the latest Schlick four turbine ETA wheel shotblast system.

A fully integrated conveyor roller system is also now in operation as well as a new treatment area featuring the most advanced heating, ventilation and extraction processes, compliant with the Pollution Prevention and Control Regulations 2000.

"The company realises it is vitally important to maximise efficiency, quality and service in order to maintain and enhance strong working relationships with clients," said Elland's Managing Director, Bob Thorpe.

AROUND THE PRESS

The Structural Engineer
1 May 2007
Structural design benefits sustainability
The steel option was chosen on the grounds that the overall structural cost was comparable, the programme faster, and construction traffic to the site was reduced. It was an additional benefit that the cost and programme savings were achieved along with superior sustainability credentials.

Construction News
17 May 2007
Cement in short supply
Precast concrete producers have been forced to lay off staff as the cement supply crisis deepens. Manufacturers across the country have had to scale back production as precast factories grind to a halt due to crippling cement shortages.

Building
11 May 2007
How's this for a car showroom?
The building is as much an engineering triumph as an architectural one. The 16,000m^2 roof contains 2,000t of steel and consists of an upper and lower skin made from a series of small steel members that follow the shape of the roof.

New Civil Engineer
17 May 2007
Engineer's guide to the FA Cup
Wembley's signature arch carries 70% of the roof load, eliminating the need for columns anywhere within the stadium bowl.

New Civil Engineer
24 May 2007
Bridged the gap
Alfred McAlpine reaches the final stages on the 220m, four span bridge over the A282 as subcontractor Cleveland Bridge lifts one of the last 90t beams in to place. Spanning the A282 between Junction 1a of the M25 and the start of the Dartford Crossing, the new £8.6M bridge passes over the toll plaza and under the QE11 Bridge.

Zero carbon building envelope

Confidex Sustain has built on the success of the Confidex Guarantee, and the Corus commitment to sustainability, and offers the first carbon neutral building envelope in the world.

It addresses a growing interest in sustainability and climate change, and the increasing demand for sustainable construction products. It provides a combined guarantee which covers the performance of the Corus Colorcoat premium pre-finished steel products and makes the pre-finished steel building envelope carbon neutral.

The product also measures the unavoidable CO_2 emissions of the pre-finished steel cladding system from cradle to grave, such as manufacture through to installation, use and end of life, and offsets the impact from the entire building envelope.

It offers more than just offsetting, and aims to encourage the specification of the most sustainable pre-finished steel products and cladding systems. Available when Colorcoat HPS200 and/or Colorcoat Prisma are specified, as part of a Corus Colorcoat assessed cladding system.

Atlas Ward expands with FICEP machinery

Equipment manufacturer FICEP has recently delivered a raft of new state-of-the-art machines to Atlas Ward Structures' facility in North Yorkshire.

The substantial order consists of a 1203 DJB (the first combined bandsaw and drill equipment in the Severfield-Rowen Group), a 1204 DJTT CNC drilling and coping line, a FICEP Tipo B251, a high-speed drilling and thermal cutting line, plus a P401/8 high-speed stand-alone CNC drilling line.

Atlas Ward is the first UK company to take delivery of a Tipo B251 which does punching, drilling and thermal cutting of large plate material from 6mm to 100mm thick.

The machine's flexibility of plate thicknesses allows both small batch and cross contract work to be carried out by a single operator. It is claimed that the unit also requires less space dedicated for material stock and therefore the operator has less inventory to manage.

Simon Barnes, Deputy Managing Director of Atlas Ward, said: "I was impressed with FICEP's manufacturing facility in Italy and the state-of-the-art technology that they have developed. Now that the FICEP installation is complete, the accuracy and speed of material processing has made a huge contribution to our current production success."

Atlas Ward says it has been particularly impressed with the new FICEP 1203 DJB which has immediately demonstrated its ability to cut jumbo and plated sections both quickly and accurately.

Inventive Swedish engineer remembered

Goran Kajrup, Owner of Roundo, the Swedish manufacturer of steel bending machines, died on 20 February 2007.

Russell Barnshaw, Director of Barnshaw Section Benders and a Roundo customer, remembers Mr Kajrup as a hard working engineer who came from small beginnings, to run the number one producer of bending machines in the world.

Mr Kajrup's involvement in the sector dates back to the 1960s when he was a design engineer at Kumla, a bending roll company in central Sweden. Towards the end of the decade he joined a small engineering company in Hassleholm, southern Sweden, and it was while working here that he came up with a unique design for bending roll.

He introduced a design with a single hydraulic motor that drove a gear that engaged with two other gears in a planetary arrangement. Up until this time all bending machines were of the pyramid type – with fixed bottom roll centres and only a two roll drive – whereas his machine had a third driven roll.

The company started manufacturing machines along Mr Kajrup's design, and later he went forward with a management buy-out and became Owner of what became Roundo.

In the early years the firm produced only small bending machines, but in the 1980s it introduced larger units to curve large structural sections, universal/wide flange beams and round and square tubes.

Mr Kajrup is survived by his wife, daughter and son Ola who is continuing the business.

Two more members join charter

The Steel Construction Sustainability Charter has recently added two more BCSA members to its list, bringing the total number of companies to have been successfully audited to 13.

After being successfully audited, Caunton Engineering was awarded Silver status and Metsec Gold status.

As part of the audit process companies are awarded points, and must score more than six points from a maximum 12. Their points tally then gains them Charter Status in three levels: Gold, Silver and Member.

The current Charter list comprises: Barrett Steel Buildings, Gold; Billington Structures, Gold; International Paint, Gold; Metsec, Gold; Cairnhill Structures, Silver; Caunton Engineering, Silver; Conder Structures, Silver; Elland Steel Structures, Silver; Fairfield-Mabey, Silver; Rowecord Engineering, Silver; ACL Structures, Member; Fisher Engineering, Member; and Graham Wood Structural, Member.

The BCSA requires that Sustainability Charter Members should make a formal declaration that consists of the following eight points:

- Operate their businesses in efficient and financially sustainable ways in order to undertake contracts that satisfy clients and add value for stakeholders.
- Work to optimise the impact of manufacturing and construction activities on the eco-efficiency of steel construction through its life cycle.
- Work towards increasing the efficiency of use of resources and energy in steel construction by promoting the recovery, reuse and recycling of steel.
- Foster the health and safety of employees and others in the steel construction industry, and operate generally in a healthy, safe and environmentally sound manner.
- Demonstrate its social responsibility by promoting values and initiatives that show respect for people and communities associated with steel construction.
- Conduct business with high ethical standards in dealings with employees, clients, suppliers and the community.
- Engage stakeholders and independent third parties in constructive dialogue to help implement sustainable development.
- Build on their knowledge of sustainability and willingly share this with others, by being open and active in communications and by helping steel and construction companies and other organisations in the supply chain to implement sustainable policies.

Cold formed products to be CE marked

The CE Marking of all cold formed products will be covered by the forthcoming harmonised standard EN 1090-1, which is likely to take effect at the end of year.

Dr David Moore, BCSA Director of Engineering, said all those manufacturers wishing to declare design characteristics of products, such as the load capacity, now have to design and/or test in accordance with Eurocode BS EN 1993-1-3.

This affects products such as cold formed purlins and rails, metal decking and metal cladding.

A new BCSA Task Group has been set up to investigate the implications of CE Marking and to monitor the development of the National Annex for BS EN 1993-1-3.

"The Annex will contain a calibration factor so manufacturers can convert their historical data into new data," said Dr Moore.

"This is to ensure all the millions of pounds previously spent on product research isn't wasted."

Vital link on River Lea walkway opened

Linking two previously unconnected parts of the 1.2km-long River Lea walkway in Enfield, north London, the Mossops Creek footbridge was officially opened in May.

The 24m-long structure was fabricated and erected by Allerton Engineering for the London Development Agency. It will help development of a nearby industrial area opened for the relocation of small businesses from the 2012 Olympic Games site.

Allerton Engineering Director, John Riddle, said: "The span was fabricated as one piece, but the arch is formed by two separate sections and these were both delivered to site in 11m-long lengths - four in total."

The entire erection of the bridge took three days and involved Allerton first lifting the main span into place with the aid of some temporary trestles.

"The trestles acted as mock foundations while we erected the arch sections, which have a maximum height of 6m," explained Mr Riddle.

The span is supported by a series of stainless steel Macalloy hangers, while the arch has five cross members connecting its two parts. The two arches also lean towards each other by 15-degrees.

Commenting on the bridge's vivid colouring, Mr Riddle said the client specified the hue in order to contrast with the surrounding buildings, which are predominantly grey.

NEWS IN BRIEF

William Hare has appointed David Thomas as its Health, Safety and Environment Director. Mr Thomas was previously the Health and Safety Executive's Principal Specialist Inspector within the Construction Division Technology Unit.

The Bourne Group has opened a new central London office at King House, 44 Copperfield Street, London SE1 0DY. The office will be staffed with a full team of designers, estimators and operations personnel, and the firms Bourne London, Bourne Steel and Bourne Engineering divisions will be represented.

More than 4,000 people from 30 countries attended the **North American Steel Construction** Conference organised by the American Institute of Steel Construction and held from 18-20 April. The annual event was held in New Orleans and the exhibition which ran in conjunction with the conference attracted more than 100 exhibitors from the steel sector.

Conder Structure's Managing Director, **Gordon Ridley** (below) retired at the end of May after 39 years with the Burton-on-Trent steelwork contractor. Under his direction the company has grown to be among the top structural steelwork firms in the UK. His successor Jason Hensman took over as Managing Director on 1 June.

New headquarters for consumer giant

Working for main contractor Bowmer & Kirkland, Caunton Engineering is currently erecting 1,200t of structural steelwork for a new four-storey headquarters for Unilever.

Located in the Leatherhead Office Park, Surrey, the building will eventually house all three of Unilever's divisions - Foods, Home and Personnel Care, and Ice Cream - under one roof following a corporate merger.

Steven Waterhouse, Caunton Divisional Director, said this is a challenging multi-storey project due for speedy completion of the steelwork by July 2007.

The company will also install more than 20,000m² of metal decking and 80,000 shear studs.

"Steelwork begins at basement level," said Mr Waterhouse. "As below the four levels of office space there is under-croft car parking."

Below ground level all columns are concrete-filled UC sections, changing to feature exposed CHS sections for all other levels.

"Another interesting element of the project are the two one-storey high podiums at each end of the building," said Mr Waterhouse. "These will provide access to the car parks as well acting as entrances to the building."

Brace for architectural feature

The unwelded FLI Brace (right) next to a traditional welded unit.

Following the success of its FLI Brace product, Francis Lewis International (FLI) plans to launch a new range of FLI truss products incorporating the brace.

The FLI Brace, which is available in diameters from 48mm to 193mm, is produced by combining the operations of tube cutting, profiling and pressing in a single operation.

As no welding is involved, the automated machinery can produce braces in a fraction of the time compared to traditional T-end units.

Tony Parker, Salesman at FLI, says because the braces have a smoother profile they lend themselves to feature architectural projects.

"The new product will be a pre-fabricated truss with FLI Braces installed, and will be ideal for stadiums or sports halls as a feature item."

Showground enlargement takes shape

A £7.8M development programme set to transform and enlarge the East of England Showground in Peterborough, is progressing on schedule for a November 2007 hand-over.

The project, which got under way in October 2006, includes the construction of a clear span Exhibition Centre and Atrium covering 5,583m², which will be linked to existing facilities, giving an overall covered area of 14,000m².

Steelwork contractor D A Green & Sons, working on behalf of main contractor Linpave Building, will complete steel erection at the end of June.

The Exhibition Hall is 100m long and 60m wide, and the spans are formed from 3 x 20m-long beams.

D A Green Contracts Manager, Ian Burchnall, said the best way to construct the spans was to erect the two end sections on temporary props and then lift in the middle piece between them to allow the required preset to be achieved.

The Hall is also formed by a series of 20m-high 508mm diameter CHS's, spaced at 10m intervals, which support the braced roof via 90mm diameter pin joints.

The Atrium also features a 5t rooflight frame (pictured above) which was delivered to site in two sections, bolted together and then lifted into place in one piece.

Diary

For BCSA seminars contact Gillian Mitchell, email gillian.mitchell@steelconstruction.org telephone: 020 7839 8566
For all Corus events visit www.corusevents.com, email events@corusgroup.com telephone: 01724 405060

6-7 June 2007
The design of steel bridges
Wrightington Hotel & Country Club, Wigan.
£215 inc VAT. www.corusevents.com,
email *events@corusgroup.com*.
t 01724 405060

12 June 2007
National Structural Steelwork Specification
Half day seminar, Huddersfield.

19 June 2007
Steel Day
Exhibition and Seminar,
Old Billingsgate, Lower Thames St, London
This free event includes an exhibition and a programme of short seminars taking place throughout the afternoon. For more information and to register please visit *www.steelday07.com*

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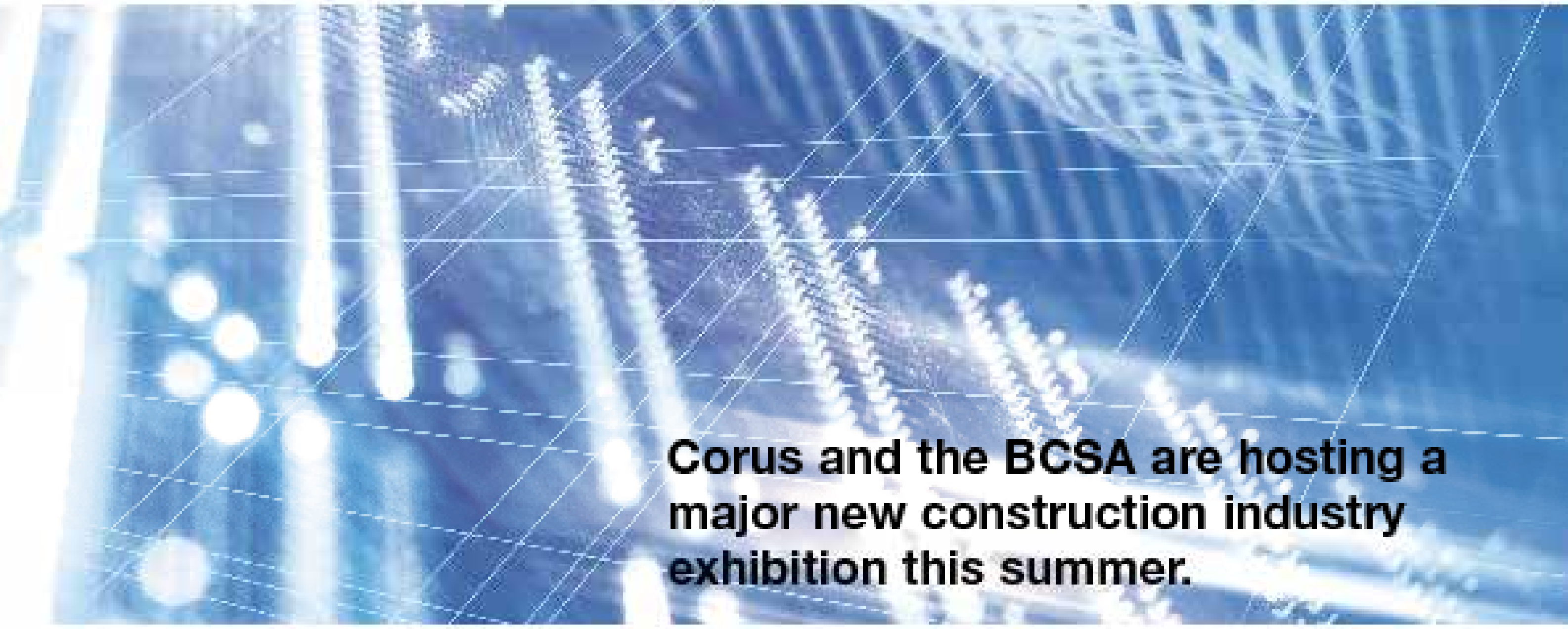
steelday



Corus and the BCSA are hosting a major new construction industry exhibition this summer.

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BCSA

corus

Structures expert is Canada bound

Charles King – well known in Britain and on the Continent for his intellectual prowess, deep understanding of steel structures and the wearing of outrageous ties – is emigrating to Canada. Ty Byrd asks him why.

Above: Charles King, with typically colourful tie.

Most engineers do not walk away from secure employment and emigrate at the age of 55. But then Charles King, the Steel Construction Institute's outstanding Senior Manager for Standards, is not like most engineers. For a start, his neckwear marks him out as a man apart. The words 'dropping' and 'acid' spring to mind when considering the state of being of who ever designed his ties. Less immediately obvious – but apparent as soon as he begins to speak – is what colleagues describe as an unparalleled knowledge of steel behaviour and the most profound feeling for steel structures, including those built to orbit Earth. He also has itchy feet and a determination to seek new challenges. Hence the decision to move to British Columbia.

"I shall be working for the bridge consultant Buckland & Taylor in Vancouver – a rare opportunity for someone of 55," he says. Buckland & Taylor is a talented designer of bridges: the cable stayed Arthur Ravenel Jr Bridge with its 471m main span is one of the firm's structures. "They have a lot of bright engineers but a number of key senior people are nearing retirement age. They need someone now who understands the fundamentals of steel and structural steel design and it seems I meet their requirements. The professional prospects are exciting and the personal ones too: life in Canada appeals to both me and my family."

Canada's gain is Britain's loss, and Europe's too. At the SCI, Charles King has been the ultimate authority on structural stability and structural mechanics plus the principal trouble shooter of design problems. He has managed the Codes & Standards department and played a substantial part in developing national and Euro steel codes, notably BS 5950 and EN 1993-1-1, for both of which he subsequently published application guidance.

He is well known and respected on the European circuit. At home, his design guides are acknowledged as first class and practical, particularly those seminal ones in the areas of portal frames and curved steel. And there are comparatively few people in the British structural steel sector who have not attended SCI training courses ably and entertainingly presented by Charles King.

"Charles has a fine engineering mind, well suited to contemplating complex matters and solving structural conundrums," says SCI Deputy Director David Brown. "He's much appreciated here by his colleagues, especially the non-engineering ones who are never fazed by him. Quite apart from being

"Charles has a fine engineering mind, well suited to contemplating complex matters and solving structural conundrums."

Above: Foam rubber aids – helping Charles King get the message of structural behaviour across, simply.

a really nice guy, he's brilliant, not least at explaining complicated things in layman's terms."

"I may have been born with some structural intuition, some inherent ability to break complex structures down to their component forms which can be more easily analysed," Charles King says. "If I was, then the man who developed this in me was Professor Arthur Bolton, my structures lecturer at Heriot Watt University in the early 1970s. His name doesn't appear on many papers – he was a modest man – but he was a structural engineer of greatness, not least at reducing difficult matters to solvable problems. He was also clear in demonstrating that, in analysis, you should look at main features and not worry about the tiny details."

Charles ended up with a first class Honours degree from Heriot Watt, plus the Watt Club Medal for his level of academic achievement. (Later he was to gain an MSc – awarded with distinction – and DIC from Imperial College and an MPhil from the University of Sheffield. He is currently pursuing an PhD at Sheffield, in the design of columns for axial compression and end rotation.) Beyond Prof Bolton, he pays tribute to certain other men who he believes have helped him develop as an engineer and person. They include Mike Fothergill, with whose structural engineering practice Charles spent valuable time in the 1970s. Mike already excelled at concrete, hence his young colleague's dedication to steel.

Another was David Manton, met up with when Charles joined Dorman Long. David was chief engineer, hugely able in electrical and hydraulic as well as structural engineering. He was a frightening, demanding man, highly effective at driving jobs forward. His creed was: "We're an intelligent bunch: what ever the problem, between us we can crack it. So let's get going." Pete Halliday (an engineering colleague at MJ Fothergill Associates) influenced Charles King in a different way.

Pete was a practising Christian who never said anything particularly evangelical but seemed to Charles a better man than he was, living a better kind of life. He subsequently discovered his own faith and – as an immensely beneficial added bonus – met his wife Stephanie while attending church. They have four children, Chloe and Henry, now young adults, and the teenage twins Joshua and Nina.

Charles King worked for a number of companies over the years, both at home and abroad, on the design of numerous complex structures. These included buildings, aircraft hangars, bridges, caissons and (wait for it) satellites, the latter for British Aerospace in Stevenage, and Matra Espace in Toulouse. Consider these words from Charles' CV, describing his activity between 1986 and 1993: 'Design for quasi-static, sine vibration, random vibration and acoustic loading of satellites and launch vehicle components (Ariane 4) in carbon fibre re-inforced composites, aluminium, titanium and other aerospace metals.....structural failure criteria including ultimate stress, ultimate strain, fatigue and fracture'. Not bad, eh?

Charles worked on the design of buildings, aircraft hangars, bridges, caissons and (wait for it) satellites

In 1993, as work in France was coming to a close, Charles was offered and accepted a senior position at SCI, where he has remained for 13 "happy, productive and fulfilling years". So, has anything changed at the institute to help prompt his emigration? "The serious problems of the last decade or so have largely been solved – and there are no great projects left to research, none that anybody's funding, at least. I need fresh challenges. And with my peripatetic background (his father was in the RAF, rising to Air Vice Marshal), moving around really is in my blood. Canada is good for me just now, and for Steph."

And the outrageous ties? "They're actually chosen for me by my wife and children. I wear them for a bit of fun, for the same reason that – when lecturing on Eurocodes – I present these as items on a French menu. It's a sad day, when you can't have a bit of fun."

New technology promises productivity boost

Nick Barrett had a chance to view the latest in state-of-the-art fabrication equipment when he visited Kaltenbach's International Partners in Steel event in Germany. Kaltenbach's healthy order book reflects the rapidly growing popularity of constructional steelwork worldwide, he learned.

Productivity and efficiency improvements made across the UK's constructional steelwork sector in recent years have been made possible by continuous investment in state-of-the-art machinery by steelwork contractors. Manufacturers have responded to this eager uptake of the best equipment they can offer by investing in research and development themselves, producing steady and sometimes dramatic improvements in the performance of the available technology.

Typical structural saw and drill lines have doubled output capability over the past 15 years. Significant gains are being claimed for several new products that were on show at Kaltenbach's hosting of the IPS event at their HQ in Lorrach, Germany, in April. Faster times for new machines executing familiar processes were claimed and some new processes such as robotic welding and contour marking attracted a lot of attention from visitors.

Visitors from growing steelwork markets across the world attended, some 3,000 people in total. There was a large group of visitors from Spain for example, which Kaltenbach says is a very fast growing market for their products. Machinery is being exported across the world, seemingly to anywhere that has a growing construction market, and waiting lists are reported for most machines in the product range – even reconditioned machines are reportedly hard to get.

The three-day IPS event brings together over 20 leading steel processing companies every two years. Several new structural fabrication machines and processes were launched that claim dramatic gains for fabricators. Star of the show was the newly introduced KWR1001 robotic structural fabrication welder, a joint venture between Kaltenbach and robotic welding specialists Cloos. These welders are claimed to reduce typical welding process times by up to 80% and fabricators were heard to welcome the prospect of removing the last human potential bottleneck in their production process.

Below: The new solid carbide drill and contour marking drilling.

Left: The star of the show - the KWR1001 robotic welder.
Below: New high speed plasma plate processing on the KF2512.

Kaltenbach Managing Director Manfred Saenger claimed a world first for fabricators in fully automated, dedicated structural welding with this machine. He said: "We have concentrated in recent years on further advancing material through-put efficiency, combined with user friendly ease of control and a range of flexible machine options to suit budget and application. CNC has been extensively deployed and in the past four years we have introduced robotics for some processes where appropriate. Our new products give some very significant benefits for structural fabricators."

The robotic welder can fully integrate into an overall CNC, CAD based structural steel fabrication process, with dramatically reduced operator costs per tonne. The welder is supplied with customer specific rig set up, comprising heavy duty, rotatable work holding face plates, one fixed horizontally and the other adjustable, with a multi axis robot driven welding head, horizontally traversable.

Special MOSES software generates the welding sequence, which can be readily adapted to suit customer specific requirements. The robot is said to be able to automatically assess and allow for typical industry material tolerance variations while ensuring the optimum weld.

Significant productivity gains were being claimed for other new machines. For example, a 400% increase in plate processing speed is claimed for a new double headed plasma plate processing centre, the KF2512, which with a 12 tool carousel cuts complex profiles, drills, taps and countersinks holes some 400% faster than its single headed counterpart.

It is said to be ideal for fittings or any plate based production. Cutting capacity thickness is 6mm to 50mm, with a finished plate capacity of up to an extra large 2,000mm x 2,500mm.

Also on show was an alternative approach to fittings or plate based production in the shape of the KPS506 punch, shear and drill, steel strip-fed system which incorporates an integrated 'plasma profiling' option for the first time. The KC1201 robotic plasma coping system which cuts complex profiles now offers new 'plasma etching' to provide positional marking for fittings and/or alpha numeric identification.

Structural drilling speeds are said to have been increased by a factor of three by using a new solid carbide drill bit on what Kaltenbac say are the world's fastest structural drilling machines, with the KDS1015 three-axis drilling system demonstrated. The specially developed drill bit is solid carbide for its full length. The new set up is said to be twice as fast as Tungsten Carbide Tipped systems and five times faster than HSS. An added benefit is the long life of the drill bit that can be sharpened many times.

This machine also demonstrated Kaltenbach's new DSTV compliant 'contour marking' high speed rotating tool which etches either the outline or corner positions onto material as a positional indicator for follow-on welding.

Among other equipment on show was the latest manipulation, column and beam bending, straightening and cambering machines from Swiss manufacturer Stierli Berger. Gietart displayed a new, completely restyled state-of-the-art shot blast and automated paint system.

Typical structural saw and drill lines have doubled output capability over the past 15 years.

Below: Robotic plasma coping with new plasma etching.

Multi-purpose scheme extends town centre

FACT FILE
Abbeygate development, Milton Keynes
Main client: *Abbeygate/Helical Bar*
Architect: *HBG*
Structural engineer: *Capita Symonds*
Main contractor: *HBG*
Steelwork contractor: *Rowecord Engineering*
Project value: *£100M*
Steel tonnage: *5,000t*

Above: The upper residential levels have a radically different grid than the lower retail and car parking floors.

Below: Erection of the residential blocks has begun before the completion of the steel transfer deck.

A £100M retail and residential development in Milton Keynes is making substantial and innovative use of steel to integrate a number of different grid plans. Damian Arnold reports.

The Abbeygate development is set to become a landmark in Milton Keynes town centre, consisting of a large Sainsbury's supermarket with 11 residential blocks set above two basement levels of car parking. The project is making extensive use of steel in order to achieve a number of different grid plans.

The project is making extensive use of steel in order to achieve a number of different grid plans

Essentially the two basement levels of car parking and the retail level all have the same column grid. However, above this the residential blocks have a much denser column grid and this has required steelwork contractor Rowecord Engineering to erect a large transfer deck above the Sainsbury's supermarket.

Under this solution, the loads from the 11 residential blocks that surround a roof garden above the ground floor retail building are transferred into the steel deck that forms part of the Sainsbury's roof structure.

The transfer deck is needed because many of the elements in the development have vastly different column configurations that could not be lined up, says Project Engineer of structural engineer Capita Symonds Peter Dawson.

"It's impossible to achieve continuity of columns because of the different demands of those spaces so we needed a transfer structure to resolve the different grids," he says.

Once clear that this was the way forward, a steel solution was the only answer because of the long spans in the transfer deck, adds Dawson.

"The biggest advantage steel has over reinforced concrete in projects such as this is that it can deal with long spans. For example, the deliveries service yard for the supermarket on the ground floor requires a 27m column free area. The retail floor above thus had to be hung from transfer beams above that which span the full width of the service yard. These beams are 2m deep plate girders each weighing approximately 30t. When you require structural members to work that hard over such a long span, steel is superior to concrete because of its tensile properties."

HBG Project Manager Chris Edwards, says that the contractor had put forward a steel frame solution at tender stage in direct competition to a rival contractor's reinforced concrete solution because it believed steel was so much more cost effective than reinforced concrete and would result in a stronger and lighter structure.

"If you were to work up a solution in reinforced concrete the structural elements would have to be very, very deep and heavily reinforced and the loads would be enormous."

"If you were to work up a solution in reinforced concrete the structural elements would have to be very, very deep and heavily →

Below: Temporary cross bracing has been used throughout the project.

reinforced and the loads would be enormous," says Edwards.

The challenge for Edwards and his team is that construction of the residential units needs to begin before the steel transfer deck can be completed.

This is because under the terms of the contract the client requires a certain amount of residential units to be ready by certain dates. Meeting those deadlines by building up the project layer by layer would have been tough, says Edwards.

> ***The challenge is that construction of the residential units needs to begin before the steel transfer deck is completed.***

"The critical path of the project is the residential buildings and keeping the momentum going right through to fit out," he says. "Therefore we have gone straight into the erection of the residential units."

And already, work is continuing apace on the residential structures with fit out and cladding under way on four blocks.

Value engineering found that they could build up "slices" of the basement floors, retail building and steel transfer deck on which the residential blocks will sit.

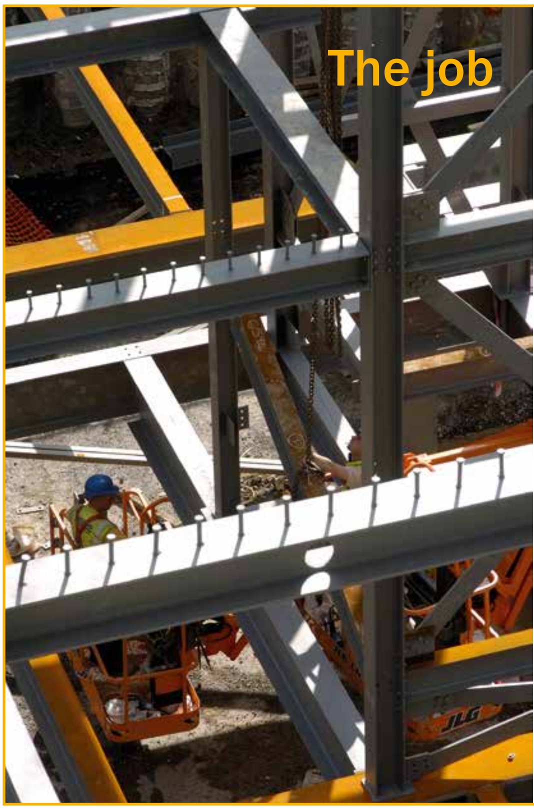
But this solution has created a big challenge for the project team to maintain structural stability of the residential blocks going up before the steel transfer deck is fully complete, says Edwards.

"When complete this will be a very stable structure but the problem we have is that we don't want to build the structure up layer by layer because we need to finish the residential units earlier and this has given us a challenge to maintain the stability of the structure as we build it."

Temporary cross and vertical bracing has been used in the basement levels and the residential blocks. And by the time the temporary bracing is removed when the residential buildings are fitted out, greater structural stiffness will have been added to the whole structure by lifting in pre-cast concrete shear walls at certain points on the lower levels. The pre-cast wall panels which are craned in and then grouted up were much quicker to install then casting the walls in-situ.

Early completion of the shear walls helps to keep the structure stable during construction when there are uneven loads on the structure.

"We need those walls operational because they provide vital structural stiffness to the overall scheme," says Edwards.



The job

Abbeygate is a large mixed-use scheme that comprises 441 residential units, a Sainsbury's supermarket as well as 10 other retail units and two basement levels with underground parking for 600 cars.

The residential units come in 11 blocks, vary from four to 10 storeys and surround a roof garden, complete with water feature, that tops the ground floor retail building. There are also two other residential blocks outside the perimeter of the main site and a nursery building.

Altogether there are 30,000m^2 of steel decking used on the job and 5,000t of structural steel. The steel is fabricated at Rowecord's facility in Newport, south Wales.

HBG started on site with a 142 week design and build construction contract in March 2006 with the driving of 500 mainly 750mm, but some 600mm, steel reinforced concrete piles and the contiguous piled wall to retain the car parking basement structure. At the time of writing the basement is dug, the contiguous wall retaining it is complete and the residential structures surrounding the site are going up.

Once the frame of the building is completed, the steelwork will be entwined with mechanical and engineering services integrated into the structural steel design rather than exposed or part of the cladding system, says Mr Dawson.

"There is a very high degree of M&E service integration within the steelwork which is quite unusual," he says. "The services run through the webs of beams and in some places we've had to allow for holes in the steelwork of up to 1m^2. It's been a very extensive coordination exercise between the structural engineer and the services engineer."

Preparing for take-off

A new eye-catching and innovatively designed control tower is nearing completion at Newcastle Airport.

The new £8.2M control tower at Newcastle International Airport is rapidly taking shape and is scheduled to be operational by the end of the year. The 45m-high structure is set to become a landmark development for the airport and will replace the present tower which was completed back in 1966.

A bespoke design has been adopted which incorporates an imposing visual appearance with a twisting lattice structure with concave sides and spiralling strips running throughout.

Rippin Steel started work on site in Summer 2006 and began by installing the low level steelwork for the tower. This consisted of a circular base which is two levels high and has a 32m diameter at the ground tapering upwards to a 22m diameter.

The low level steel was erected on top of a concrete slab and around the concrete core which rises to a height of 40m. This core shaft will house the tower's lift, risers and stairs.

David Jamieson, Rippin Steel Managing Director, says the most challenging aspect of the project was erecting the uppermost module of the tower.

Rippin decided to trial erect the top of the tower at its yard before dismantling it and bringing it to site. The company then re-assembled it at the airport with the aid of a jig and then lifted the entire fully decked and clad 50t section in to place with a 500t mobile crane.

"This section is a very complex two-storey structure which has tapered elevations and is circular in plan with a fully welded braced frame made from 203mm x 203mm columns and eight tubular RHS columns," explains Mr Jamieson.

Nils Clemmetsen, Associate at project structural engineers Arup, says a key requirement of the job was to design the upper module to be erected safely and economically.

As the plant installation on the roof of the lower level of the steelwork was in progress, lifting the upper section and placing it on top of the tower was the only viable solution.

"The design incorporates some extra bracing around the parapets," says Mr Clemmetsen. "This was needed to minimise movements on the pre-clad frame during the lifting process."

The final high level steel element of the tower slips over and around the top of the concrete shaft to very fine tolerances and is fixed into pre-formed pocket connections.

To connect the top and lower levels of steelwork, a galvanised tubular CHS framework infilled with a stainless steel mesh is now being installed to create the tower's innovative curved profile.

Above: A tubular CHS framework will form the curved profile of the tower.

Middle left: The tower's top was assembled on site with the aid of a jig; Middle right: A 500t capacity crane lifted the entire module into place; Bottom: How the completed structure will look.

FACT FILE
Newcastle Airport Control Tower
Main client: *Newcastle International Airport*
Architect: *Reid Architecture*
Structural engineer: *Arup*
Main contractor: *Sir Robert McAlpine*
Steelwork contractor: *Rippin Steel*
Project value: *£8.2M*
Steel tonnage: *1,600t*

Steel Construction Books

BCSA

Health & Safety • Specification • Assessment • Erection • Design

NEW

DESIGNING - The Red Book

The Handbook of Structural Steelwork

This handbook gives practical design advice, worked examples, section properties and member capacities. This edition includes the additional 21 new Advance sections produced by Corus and the section property and member capacity tables have been dual titled to reflect the relationship between BS 4 sections and the Advance range of sections. The tables for hot-formed tubes have also been dual titled. The handbook is in accordance with the recommendations given in BS 5950-1: 2000.

NEW

DESIGNING - The Blue Book

Steelwork Design Guide to BS 5950-1: 2000

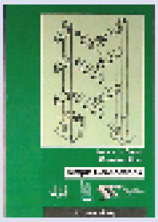
This edition of the Blue book gives a comprehensive range of member property and capacity tables in accordance with BS 5950-1 : 2000. It includes the 21 new Advance sections produced by Corus and the section property and member capacity tables have been dual titled to reflect the relationship between BS 4 sections and the Advance range of sections. This edition also includes a wider range of hollow sections. The tables for hot finished hollow sections have also been dual titled to show the relationship between BS EN 10210-2 sections and the Celsius range of sections.

NEW

SPECIFYING - The Black Book

National Structural Steelwork Specification

The 5th edition is a half-way house between the 4th edition and requirements of the forthcoming European standard EN 1090-2. Some of the changes include updating the specifications for steel sections, bolts and welding, the introduction of BS EN 5834 for the management of welding activities, a section on LMAC, an updated table on bold times and a new annex giving guidance on visual inspection of welds.



CONNECTING - The Green Book*

Joints in Steel Construction: Simple Connections

Design guidance and worked examples based on BS 5950 - 1:2000 for connections in buildings designed as braced frames where connections carry mainly shear and axial loads only.

STEEL DETAILING - The Magenta Book*

Steel Details

This book provides practical advice on the issues that affect the efficient detailing of steelwork connections. The publication contains a rich array of details from actual structures and allows both engineers and architects to interrogate them.

STEEL BUILDINGS - The Silver Book

Steel Buildings

This book covers everything from steel design; section property tables; industrial and multi-storey buildings; cladding and decking; through to fire; transport and erection; software; contracts and case studies.

GALVANIZING - The Beige Book

Galvanizing Structural Steelwork

An approach to the management of Liquid Metal Assisted Cracking. Practical guidance to clients, specifiers and engineers identifying circumstances where any increased risk of LMAC can be ameliorated.

SPECIFYING - The Grey Book

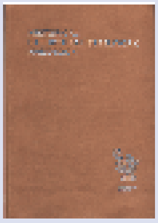
Commentary on the 4th edition of the National Structural Steelwork Specification

This publication provides useful guidance to both specifiers and contractors and can be used as an informative reference.

BRIDGES - The Purple Book

Steel Bridges

A practical approach to the design of steel bridges for efficient fabrication and construction.



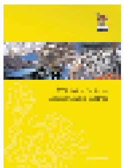
ASSESSING - The Brown Book

Historical Structural Steelwork Handbook

Developments from the mid-19th Century in iron and steel and the changes in design, loading and stresses; tables of section properties rolled since 1887; guidance on assessment of existing structures.

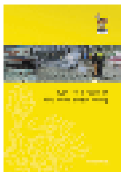
Code of Practice for Erection of Multi-Storey Buildings

The document provides guidance to clients, planning supervisors, principal contractors, designers and steelwork contractors on management procedures and methods, erection method statements, site preparation, delivery, storage, stability, lifting etc and site compliance with the Health and Safety at Work Act.



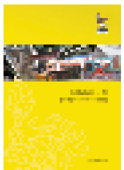
Code of Practice for Erection of Low Rise Buildings

Invaluable guidance on the safety aspects of: site management & preparation; delivery, stacking & storage of materials; structural stability; holding down & locating arrangements for columns; lifting & handling; interconnection of components.



Code of Practice for Metal Decking & Stud Welding

Clear, unambiguous and practical information for Clients, Planning Supervisors, Principal Contractors, Designers and Steelwork Contractors about the systems of work to be employed on site together with the required site safety attendances.

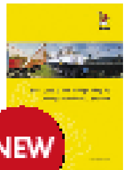


Guide to the Erection of Steel Bridges

Cover all aspects in the planning and implementation of the safe erection of a steel bridge so that personnel in the whole team will benefit from a better understanding of the erection process. The guide is complementary to the publication Steel Bridges.

Guide to Steel Erection in Windy Conditions

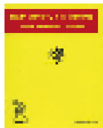
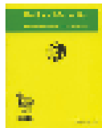
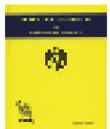
Covers issues as the maximum wind speed in which steelwork should safely be erected, the role of management and supervision of controlling work etc. Advice is also provided for designers concerning aspects raised by the effect of wind on steelwork during erection.



NEW

Guide to Work at Height during the Loading and Unloading of Steelwork

The aim of this guide is to improve health and safety during loading and unloading of steelwork from lorries and trailers that takes place either at the steelwork factory or on sites. It describes the management procedures and methods to be adopted for access and working at height and is intended to serve as a standard reference when drafting site-and project-specific method statements.

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For help and advice on steel construction and information about companies and suppliers visit www.SteelConstruction.org

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See www.SteelConstruction.org for special offers!

Above: Barrett Steel Buildings designed this building so that it could be easily disassembled at the end of its working life.

Sustainable steel combats climate change

Steel's almost unique ability among construction materials to be reused or recycled is its most obvious sustainability strength. In the second article in our series on sustainability, Nick Barrett describes these key features of steel that are becoming vital to the world's climate change

All steel products contain some recycled content.

Steel is the most recycled material in the world and can be recycled again and again without any loss of properties. Many steel products like structural sections can easily be reused in the construction industry, which means that steel has a value at the end of a building's life, rather than being the cause of a demolition cost. Recycled steel is critical to the manufacture of new steel and globally over 40% of all steel is made directly from recycled material. All steel products in fact contain some recycled content. The value of used steel is such that most of the world's steel is kept in continuous productive use.

The recyclability benefits of steel mean that specifiers are already making a substantial contribution towards sustainability simply by selecting steel as a framing material and for other construction uses.

Steel's recyclability enhances the drive towards more prudent use of the world's resources. Using steel will often make the difference between achieving other social objectives like achieving stable levels of economic growth and allowing social progress to be made.

In the UK some 94% of steel from deconstructed buildings is either reused or recycled.

Steel frames are basically made up from components, manufactured offsite in controlled factory conditions and brought to site only when needed and finally assembled. This component nature of steel frames means that their reuse can be simply achieved.

Steel frames can be easily dismantled at the end of their working life for a particular use at the original location, which reduces the end of life impact associated with demolition of other types of buildings on local communities. Far less waste has to be carted off site and sent to landfill. As steel buildings are lighter than concrete equivalent frames they need lighter foundations, which also means less material has to be extracted from the ground when buildings are demolished – and steel piled foundations can be simply extracted and reused or recycled rather than leaving an expensive legacy problem in the ground as is the case with reinforced concrete foundations.

Steel frames provide buildings that are flexible in use and easily adaptable for changing uses or changing requirements of the building users, so can have longer lives than buildings built with other framing materials – longer life means less need to demolish and hence recycling and re-use. They can also be easily upgraded to meet new environmental standards that society wishes to achieve during their working lives.

Waste created during the manufacture of steel components is less than 3%, and all of this is recycled. On construction sites, where waste has been highlighted as a significant problem, there is virtually no steel waste . In steelwork contractors' fabrication facilities all scrap steel is sent for recycling and even the amount of scrap created this way has been reducing substantially in recent years thanks to staff training and new procedures being adopted. Waste related KPI's are adopted and monitored by steelwork contractors on site.

Demountable buildings by design

Constructional steelwork designers are responding to society's desire for sustainability by producing more structurally efficient, economical designs that allow steel use to be minimised and allow for the end of life reuse or recycling. Recycling is being built into steel buildings and other structures.

Recycling is being built into steel buildings and other structures

A good example of this was when steelwork contractor Barrett Steel Buildings worked together with its client major property developer ProLogis Developments to design a building that could be easily disassembled at the end of its working life, maximising the potential for reuse of steel for no additional cost. The building selected was a 50,000 sq ft warehouse at ProLogis Park, Heathrow, that also included a 5,000 sq ft office, and goods and entrance canopies. The warehouse is 99m long, built in mostly eight metre bays, with twin 23.6m spans. It is 10m high to the underside of the haunch,

All of the steel sections used were stamped with the section size and steel grade to allow for easy identification when the building is eventually deconstructed. Barrett Steel Buildings value engineered all the sections during the design stage to ensure that the reuse potential was maximised. In practice this meant that the design minimised welding and notching, and maximised bolting which would allow for fittings to be easily removed.

This highly sustainable building is now let to airport operator BAA Plc after being assembled on time and to budget and the approach is being further developed with ProLogis, as well as being offered to other clients who are looking for more sustainable and demountable buildings.

The 2012 Olympic Games in London are expected to heighten the focus on the demountability and other reuse characteristics of steel. London's winning Olympic Games bid contained promises regarding legacy uses of stadiums and other structures which can only be met thanks to the ability of constructional steelwork to be sustainably demounted and reassembled elsewhere, perhaps in other parts of the country, once the Games are over.

Following the steel trail

Where does recycled steel go to? Corus were curious to know the answer to this question and saw an opportunity to increase knowledge in this area when its Lackenby open hearth steel plant was demolished. There was 20,000t of structural steel in this gigantic building that was 330m long, 39m high and 70m wide. The 1956 built structure dominated the site at Corus' Teesside steelworks. After 20 years use the plant was converted to a materials storage facility but by 2004 the nature of the steelmaking operation at Teesside meant that its useful working life had ended and it was to be demolished.

Dismantling and reuse was considered but several factors militated against this: there was an issue with safe access to the building for contractors, it was constructed using welded and riveted joints rather than the bolted connections that are used in today's structures, and the building, because of its unique industrial role, had been designed using non standard section sizes.

Recycling this steel saved enough energy to supply 3,700 households with all of their energy requirements for a year.

Demolition was achieved easily and the steel was sent for recycling into the furnaces operating at the Teesside steelworks over a six month period. New steel using this material was supplied to hundreds of customers who used it for a wide variety of purposes.

Corus tracked where the steel went to and what it was used for. The new steel was manufactured as sections, plates and strip steel before being supplied to external customers. A substantial amount was used for the manufacture of structural steel sections, supplied to steelwork contractors who used it on Heathrow's new Terminal 5. Other sections found their way into the new stand at London's Oval cricket ground.

It was used in the manufacture of steel plate that was used for construction of buildings over Paddington Railway station in London. Other plate was fabricated into large girders used on the construction of the A249 bridge to the Isle of Sheppey in Kent.

Some was used in the manufacture of galvanised strip steel to make light steel framed houses. Strip steel supplied to the Royal Mint was used to make copper plated one pence and two pence coins. Strip steel found its way into the manufacture of automotive parts.

Recycling this steel saved enough energy to supply 3,700 households with all of their energy requirements for a year.

Above: Recycled steel from Corus' Teesside works has been traced to the Royal Mint for the production of coinage.

Precision engineering for London office block

Computer-driven and time saving fire engineering has resulted in a more cost effective construction programme on one of London's latest multi-storey office developments. Martin Cooper reports.

Much of today's construction is governed by cost and efficiency, and increasingly sustainability. Consequently, when an opportunity arises to make substantial cost savings and use fewer materials during the works, the opportunity simply has to be taken.

A case in point is British Land's latest multi-storey office development in central London. Known as Ludgate West, the building is situated on Farringdon Road and is only a stone's throw from St Paul's Cathedral.

"The models allow us to predict the real fire performance of the structure under realistic exposure conditions."

The building will eventually offer 11,800m² of office space on ten levels and is a steel framed structure comprising a concrete basement level and two concrete cores.

Adam Bradshaw, Structural Engineer at project architect and structural engineer Skidmore Owings & Merrill (SOM), says early in the design process it was proposed that some of the steelwork's intumescent fire protection could be downgraded from 90 minutes to 60 minutes.

"Many of the structural beams have a 60 minute rating and a lot are completely unprotected," he says. "This has meant substantial cost savings to the client."

Buro Happold, along with consultants Roger Preston & Partners, were brought on board to coordinate and ensure an integrated approach was under taken for the fire engineering.

The design team put forward the suggestion to re-engineer the fire rating to the client British Land, and the decision was taken to go ahead.

Neal Butterworth, Project Engineer for Buro Happold, says this kind of approach is becoming more commonplace due to greater use of computer software packages - in particular the Vulcan software developed in conjunction with Sheffield University (see box story) - and the realisation of the savings to be had.

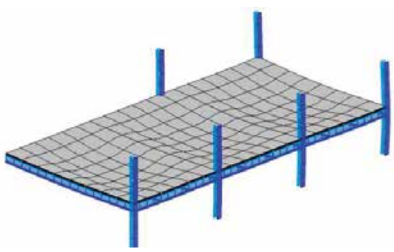
"The cost issue is the best way of selling this approach to the client," says Mr Butterworth. "But there is also a purist element for engineers because the models allow us to predict the real fire performance of the structure under realistic exposure conditions."

Above left and above: Up to the 6th floor the building is clad with limestone, while above this level the walls are glazed.

Above right: All metal decking was cut to size off-site to speed up installation.

FACT FILE
Ludgate West, Farringdon Road, London
Main client: *British Land*
Architect & structural engineer: *Skidmore Owings & Merrill*
Structural fire engineer: *Buro Happold*
Consulting fire engineer: *Roger Preston & Partners*
Main contractor: *Sir Robert McAlpine*
Steelwork contractor: *Severfield-Reeve Structures*
Steel tonnage: *1,200t*

Ensuring a better performance



Below: Vulcan output for the Ludgate West project showing the vertical supports and the deflection of the unprotected beams.

The Vulcan fire engineering software is marketed by Vulcan Solutions, a company set up jointly by the University of Sheffield and Buro Happold. Since its launch it has been used by leading specialist consultants to support advanced fire engineering design and fire protection strategies for major construction projects.

The software allows advanced fire engineering to be realised quickly and easily, by giving reliable levels of safety and robustness. Other advantages include the cost savings made from reduced applied protection, shorter site construction times and reduced maintenance.

VulcanLite, a specialist user interface that has been developed for simple buildings, is easy to use, and requires no knowledge of finite element analysis. Data is entered using simple forms, while the analysis uses the Vulcan engine. Results such as deflections and member forces versus temperature, can be output in a form directly suitable for presentation.

Vulcan has been extensively validated against a range of data including the results of the fire test programme at BRE's test facility at Cardington.

The initial fire engineering design process involved Buro Happold deciding what areas of steelwork needed protecting and then working around some worst case scenarios with a computer model of the project.

Using the generic approach within prescriptive guidance would require maximum fire protection to everything, but the computer model was used to work out where this could be reduced and which areas didn't need protection at all.

"The advantages of having the software package is that it shows the margin of safety," explains Mr Butterworth. "The modelling demonstrates exactly what fire protection is needed, how much and where."

"The modelling demonstrates exactly what fire protection is needed, how much and where."

After working out the various fire engineering parameters the design team decided that all columns would need 90 minutes protection, while beams connecting to columns would get 60 minutes. Beams connecting to other beams or to the cores were left unprotected.

"By using the software model we were able

Ludgate West stands on an historic site once occupied by the Fleet Prison and later by the meeting house where the Labour Party was founded in 1900.

to determine which structural members actually needed fire protection," adds Mr Butterworth. "Savings were made as less intumescent paint was used and less painting was required after the fabrication process."

Andy Rae, Project Manager for Severfield-Reeve, says all intumescent paint was applied off-site, and as some steel members only had a primer coating, the overall fabrication process was therefore quicker.

Commenting on this kind of fire engineering, Mr Bradshaw adds that SOM has done work of this nature before on multi-storey projects, as it means considerable cost savings to the client. "The beams which are protected provide the structure's lateral stability, while the unprotected secondary beams wouldn't fail in a fire."

However, to compensate for the downgrading of the fire protection on some of the beams, some of the areas around the cores and staircases were also kept at 90 minutes.

Once the design process had been completed, the steelwork fabrication was able to begin. The project has a tight 66-week programme with completion set for this October.

Consequently, once the concrete cores were finished, steelwork erection began in August 2006 with the last beams being lifted into place in January 2007.

British Land's involvement in the project actually dates back to the demolition of Caroone House, which occupied the site from 1969 until it was pulled down in 2004. At this time however, the London property market had hit a glitch and so nothing much happened except for the construction of the concrete basement and slab.

However, last year the market had improved sufficiently for construction work to properly get under way.

Ian Rimmer, Project Manager for Sir Robert McAlpine, says by the time his company were awarded the build contract the lower basement level was already completed under a separate contract.

"From May 2006 until July, we initially concentrated on getting the two main concrete cores up," says Mr Rimmer. "Once these were complete, the steel frame could begin to be erected."

Each floor has open plan office areas with no internal columns. Radiating out from the two centrally located cores, there are long span composite floors in 13.5m x 9m grids.

"Steel was the obvious choice for this project as the timescale was so tight and its much quicker to build with than concrete," adds Mr Rimmer.

As with most inner city developments there were minimal set down areas available for materials. Consequently, steel was delivered to site on a just-in-time basis, and the project's two tower cranes used to capacity.

"There were standard tolerances with this job," explains Mr Bradshaw. "The cores provide the stability, while around the perimeter there are moment connections."

Mr Rae says the steelwork erectors worked in two zones, north and south. By dividing the project in half, they were able to erect two complete floors and then hand these over to the deckers. While steel was being erected in the other half of the project the steel decking was being installed on the first sector in readiness for the next two levels to be erected.

From ground floor to the sixth level the building has sheer elevations on all sides. However, from here on up the structure has three steps on the west and south elevations, taking in the seventh, eighth and ninth floors. These small terraces are 1m deep on the west (Farringdon Road) side, and approximately 500mm deep on the south side.

"We had to erect 900mm deep beams along these steps, otherwise the beam members are uniformly 550mm deep cellular sections. These were required to accept all of the services," sums up Mr Bradshaw.

Below: Steelwork progressed on schedule even though deliveries had to be made to the congested site location.

Ship-shape and steel fashion

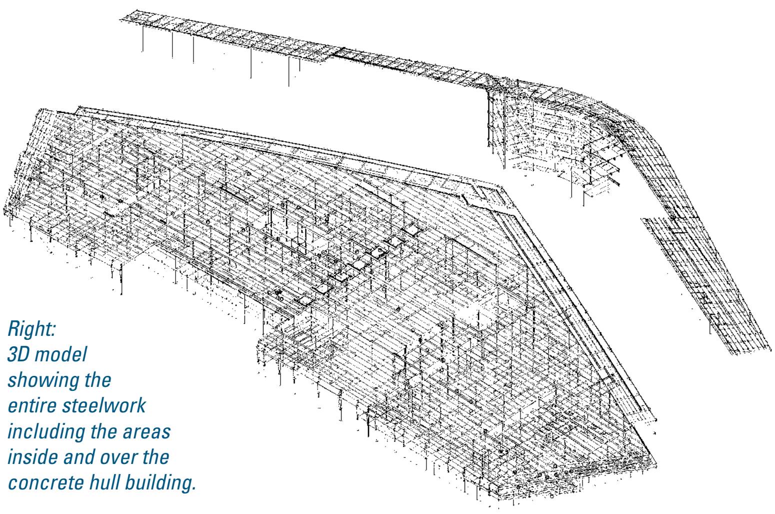
At either end of the steel section there is an 8m cantilever.

FACT FILE
Middlesbrough College, Middlehaven
Main client: *Middlesbrough College*
Architect: *SMC Hickton & Madeley*
Structural engineer: *Faber Maunsell*
Main contractor: *Laing O'Rourke Construction North*
Steelwork contractor: *Elland Steel Structures*
Project value: *£68M*
Steel tonnage: *1,600t*

Teesside's maritime heritage has provided the inspiration for the design of a new educational facility in Middlesbrough. Martin Cooper reports on a project which forms the initial stage of a large waterfront regeneration scheme.

Middlehaven, which lies adjacent to Middlesbrough town centre, was a thriving and vibrant dock in the 19th Century and acted as the catalyst for the industrial growth in the surrounding Teesside region.

The dock owed its existence to the extension of the Darlington to Stockton-on-Tees railway in the 1840s, brought about by the need to find a deepwater port facility for transporting coal to London. The River Tees at Stockton was found to be too shallow to accept large vessels and an area downstream, at present day Middlesbrough, was chosen.



Right: 3D model showing the entire steelwork including the areas inside and over the concrete hull building.

However, in recent years, the economy has changed dramatically and many of the key local industries have become redundant. Coal isn't mined in the area anymore, let alone delivered to London, and the dock has been closed since 1980.

Recently an £18M reclamation project encompassing some of the dock's basin has been completed. This has added land to a waterside regeneration site covering more than 250 acres, which has been prepared for a large-scale mixed use development.

Situated between two of Middlesbrough's most striking landmarks - the Transporter Bridge and the Riverside Football Stadium - one of the development's initial projects is a new 32,000m^2 sixth form college. Known as Middlesbrough College Middlehaven, it will cater for 20,000 students and will replace four educational establishments currently dotted around the town.

In keeping with the area's maritime heritage the inspiration for the design of the college is based on a ship at sea. Jon Leach, Project Leader for Faber Maunsell, says: "One of the two blocks, a five-storey building, is known as the hull, while the large two-storey steel sector has a wavelike roof and this could be interpreted as the sea."

The college is essentially divided into these two parts: the five-storey concrete framed structure which is slightly pivoted around the main entrance and a semi spherically shaped steel-framed two-storey structure at the back. Both sections are separated by a covered street, which varies in width from 6m to 22m, and shares the same steel roof has the steel structure.

The concrete block will eventually accommodate class rooms and offices, while the steel structure contains a sports hall, theatres and workshops. "There are some long spans in this building, up to 30m in the sports hall, which is why steel was chosen for this section of the project," explains Mr Leach.

However, it was the steelwork's complex geometry which presented the most challenging aspect of the project. "Especially under the very short timescales involved," says Mr Leach.

This saw the design of the scheme progress from felt pen mark-ups in January 2006, to a frozen tender scheme in June and then arriving at a coordinated construction design by August 2006.

The complexity of the geometry not only stems from the steel structure's semi spherical shape, but also the fact that one building will contain numerous different elements each with their own spatial and educational requirements. As well as the sports hall, a number of other modules with column free long spans are being incorporated, including a theatre and workshops.

This results in the grid pattern varying from anything from 6m x 4.5m up to 6m x 10m. For stability, cross bracing has been placed at various discrete points around the grids throughout the structure, such as beside the staircases.

"The majority of the building is two storey, but in the middle there is a double level sports hall with long 30m-long spans," says Mr Leach. "This again, radically alters the grid pattern. We have attempted to rationalise the grid where possible to economise the structure, but also to give a more ordered appearance where the structure is exposed."

John Richardson, Elland Steel Contracts Manager, comments that steel erection began in March and is due to finish in September. "When we came on site the concrete slab for the steel structure was already down and this allowed us to run mobile cranes on it which has eased our work."

Elland Steel has divided its erection programme into three phases, explains Mr Richardson. "We'll erect the main steel structure, then the building's wave-like roof and finally the entrance area in the hull building and a steel roof which wraps over it."

Once the project is complete, the steel wave-like roof will be one of the most eye-catching elements. At its longest the roof is 207m and at its deepest 82m. However, the structure is based on a segment of a sphere, and consequently the wave-like curve will be visible from whichever angle it is viewed from.

"The roof curves in both directions," explains Bob Pawlett, Project Coordinator for Elland Steel. "However, it's a large curve with the radius close to 1km away, which would be well underground."

The geometry of this steel roof also incorporates the covered street which separates the two main buildings. It is at roof level that steel connects into the concrete hull structure via a number of plates cast into the precast columns.

"Because of the shape of the roof there are varying eaves around the structure, while the bearing connections into the concrete structure were a challenge to get them in the correct positions," says Mr Leach.

The steelwork is generally set at 6m centres and this doesn't necessarily match up with the concrete grid. "The corbels supporting the bearings were cast at different levels to suit the varying roof levels and the steel consequently connects into columns and sometimes into slab," add Mr Leach.

Another important steel part of the project is the entrance and adjoining foyer area which is actually inside of the concrete hull building and connects into the covered street.

Elland Steel will erect approximately 150t of structural steelwork for the entrance and this includes five feature bridges at each floor level. Incidentally, the company will also erect another four 6m-long bridges over the covered street, connecting the first floor of the steel building with the concrete building.

"There are some long spans of up to 15m in the entrance foyer and back propping wouldn't have been possible in concrete," says Mr Leach, explaining why steel was again chosen.

The five bridges traversing the entrance get progressively shorter (first level bridge is 20m-long) as the foyer narrows towards the top.

All of the bridges are suspended from steel hangers and a large steel transfer structure with a movement joint at one end and connections into the concrete interior wall at the other.

Summing up on why steel was used for this project, Mr Leach says the building is positioned over a buried dock wall and column loads are transferred over the wall on piled transfer beams spanning up to 12m.

"The use of steel for large sections of the building has limited the overall weight of the building and hence assisted in limiting the scale of the transfer structures in these areas," he says.

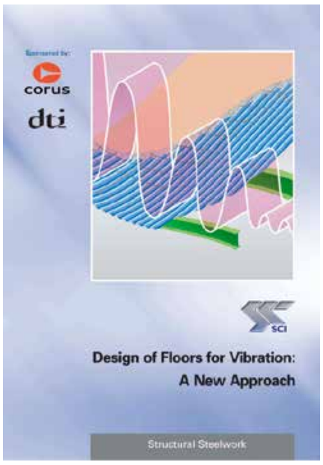
The College is due to be completed in time for the 2008 Autumn term.

Above: Interior and exterior architects' impressions of the covered street.

Below: The steel structure has a number of differing grid patterns.

Design of Floors for Vibration: A New Approach

New design guidance from SCI, including a section dealing with hospitals, lays to rest worries about the vibration performance of floors of steel framed buildings. New methods of assessment are the biggest change, as SCI's Andy Smith explains.



1. Introduction

In 1989, the Steel Construction Institute produced publication P076[1] entitled 'Design Guide on the Vibration of Floors'. From vibration measurements taken over the last 10 years on steel-framed floors, it was decided that a new version of the publication was required: to extend the guidance to new forms of construction (such as *Slimdek*®); to include guidance on special floors (such as dance floors); and, from calibrating numerical models against test performance, to develop a new design methodology. Following the publication of P354[2] entitled 'Design of Floors for Vibration: A New Approach', P076 and P331[3] have been withdrawn. This article reviews the new publication, indicating and explaining changes.

2. Sources of Vibration

There are many sources of vibration in buildings, from external sources such as traffic and train lines to internal sources such as machinery. However, the common source of vibration on most floors will be caused by the occupants, in most cases by walking. Previously it was suggested that walking can occur between 1.4 Hz and 2.5 Hz (i.e. 1.4 to 2.5 steps per second), but by considering a large number of measurements taken during a European project and using statistical techniques in Annex C of EN 1990[4], this range has been reduced to 1.8 Hz to 2.2 Hz for design. This research has also indicated that four, rather than three, harmonics of the pace frequency should be considered, and so the cut-off between a low and high frequency floor has risen to 10 Hz to take account of the off-resonant excitation of the fourth harmonic.

Guidelines for vibration caused by aerobic and dancing activities (as found in gyms, dance floors and rock concerts) are also included with a method for calculating the dynamic design load in these circumstances (which can be used as an alternative to designing above the 8.4 Hz limit specified in Annex A of BS6399-1[5]).

3. Design Considerations for Floors

As well as giving design values for the elastic modulus of the concrete and the critical damping ratio, the publication gives a recommended level of imposed load that should be taken in vibration analysis. Guidance is given on the structural and architectural layouts of a building, drawing attention to the potential pitfalls of cantilevers and precast concrete units without a structural topping, and to the importance of the location of walking paths or aerobic areas.

4 Acceptability of Vibrations

In P076 limits were given for the response factor, R, for three types of offices (general, special and busy) in the spirit of BS 6472:1984. P354 reviews all of the limits specified in British Standards (BS 6472:1992[6] and BS 6841:1987[7]) and International Standards (ISO 2631-1:1997[8], ISO 2631 2:2003[9] and ISO 10137:2006[10], which are appropriate for design to the Eurocodes), including multiplying factors that limit the response factor, and frequency weighting curves. The curves reduce the effect of high or low frequency vibration as humans cannot perceive these vibrations as much as vibrations at frequencies of the order of 8 Hz. Examples of these curves, with the asymptotic approximations that are introduced in P354, are shown in figure 1:

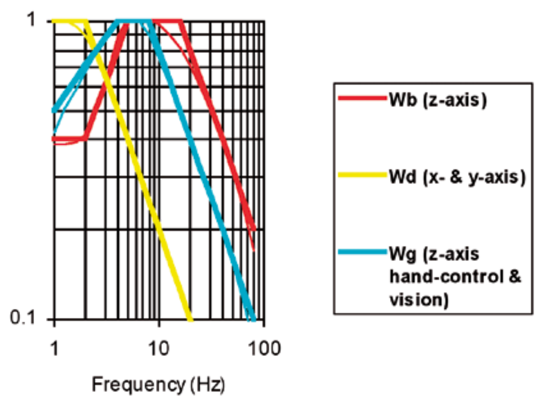


Figure 1: Frequency weighting curves from BS 6841.

Also introduced are vibration dose values (VDVs), which consider the intermittency of the walking activity, and allow the response factor thresholds to be exceeded occasionally, which are dependant on the environment and time of day. This method is not appropriate for sensitive areas (such as hospitals

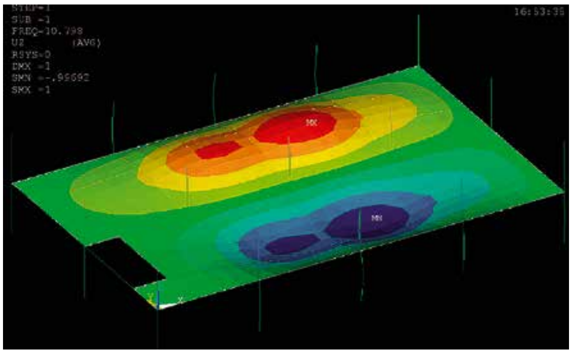


Figure 2: Example output from FE modelling (first floor of SCI office).

and precision laboratories) as in these circumstances even one small period of excessive vibration can have damaging consequences. Further information on VDVs is presented in AD312[11] (see page 34).

5. Assessment Methods

The methods of assessment are the major change between the publications, as P354 introduces the processes and equations required to run a finite element analysis of a floor and perform a subsequent modal superposition to establish a response.

The first stage in this process involves producing or adapting a finite element (FE) model (such as that shown in Figure 2), and advice is given about suitable modelling procedures, such as boundary conditions, element types and how to model steel-concrete composite floors. Once the model has been established and a modal analysis has been performed by the FE software, several outputs are required to calculate the floor response using modal superposition. The outputs, their significance, and how to obtain them (if they are not easily available) are detailed in the publication. Formulae for determining the response in terms of acceleration and a response factor are given for both low frequency floors (where the fundamental frequency is below 10 Hz, and the floors may be subject to both resonant, as shown in Figure 3, and transient response) and high frequency floors (where the fundamental frequency is over 10 Hz and the floor will only respond transiently), which include the methods of frequency weighting described above. Once the response has

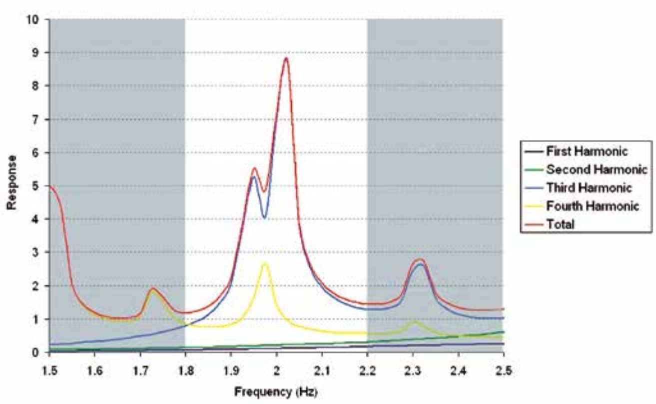


Figure 3: Example of resonant response at a range of pace frequencies.

been determined, the calculation procedure for VDVs (described above) is given. The response factor and/or VDV can then be directly compared to the acceptability criteria.

Finite element analysis may not be available or cost effective in all circumstances, so a design method based on a parametric study of a large number of finite element models of a wide range of floors is also provided. Extended guidance on calculating the fundamental frequency of a floor is given first, and then equations for calculating the response of the floor are presented. The equations are similar to those given in P076 (and the subsequent advisory desk notes), but are generalised to apply to all floor layouts, and separate equations exist for construction using shallow decking with downstand beams and deep decking with slim floor beams (such as the *Slimdek*® system).

Also included in both assessment methods are techniques to reduce the level of response by examining practical considerations such as the location of walking paths relative to working areas and the length of time it takes for the response to build up relative to the length of a walking path. The former of these is especially useful in buildings with critical working areas, such as hospitals; by considering the relative locations of a corridor and an operating theatre (which is normally fixed in position owing to the amount of services demanded for this special environment), the response factor obtained from analysis can be drastically lower than when looking for the worst case on the entire floor. Figure 4 shows the effect of this with both physical testing and finite element analysis of four steel-framed hospital floors.

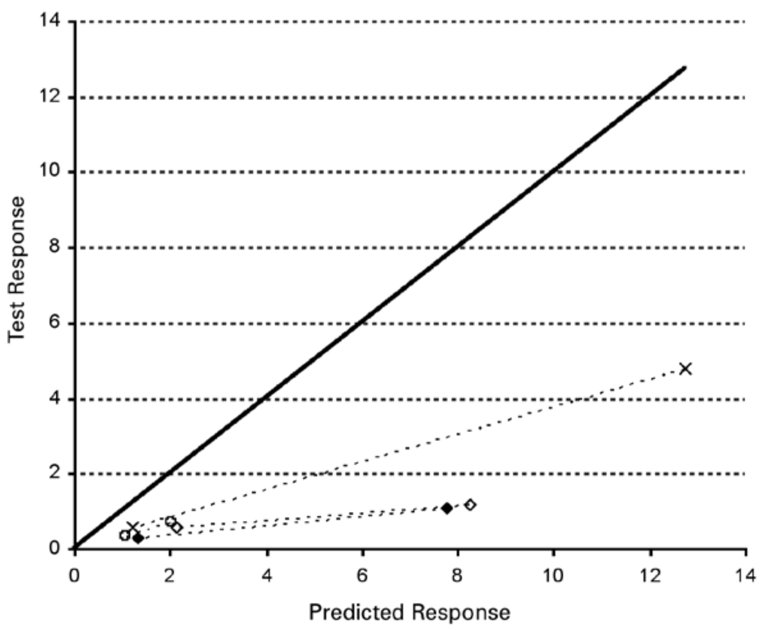


Figure 4: Predicted and measured responses for four hospital floors, showing the effect of considering the relative locations of walking paths and critical working areas.

6. Lightweight Floors

Lightweight floor construction, where floor panels made from materials such as chipboard are supported on cold formed steel C-sections, is also reviewed. Guidance is given for a response analysis of these floor types which can be used as an alternative should the frequency/stiffness criteria presented in SCI P301[12] (and reproduced in P354) not be appropriate or if the design specification requires particular response factor or VDV limits.

7 Hospital Floors

P354 will also replace the previous guidance given in SCI P331[3], and a section dealing specifically with hospital floors is provided that summarises the requirements that are specific to hospitals (from publications such as HTM 2045[13]) for use with the assessment methods that are general for any floor.

8 Appendices

As well as the worked examples and a comparison of test results with the assessment methods, two other appendices are provided for information. The first of these examines retrofit and remedial measures to improve the performance of floors due to a change of use or in the rare case of a problematic floor. The second is a chapter on the dynamic testing of building floors, written by Professor Aleksander Pavic and Dr Paul Reynolds, both of Sheffield University; this gives an overview

Figure 5: Electromagnetic shaker testing in a hospital corridor.

of the various methods of testing a floor, from an ambient vibration survey (where the response of the floor due to common background vibration is measured) to testing using specialised equipment, such as computer controlled shakers, as shown in Figure 5. The analysis of the test results to demonstrate compliance with specified limits or to advise on possible remedial action is also considered.

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AD 312
Vibration Dose Values

Introduction

BS 6472[1] is the appropriate Standard in the UK when considering the exposure of humans to vibrations. This Standard covers many vibration environments in buildings and, to achieve this wide coverage, limits on continuous vibrations are expressed using multiplying factors. Design guidance on floors was first published by the SCI in 1989[2], which provided a calculation methodology to enable predictions of the floor response to be made through the use of the response factor, R. Provided that the response factor was less than the appropriate multiplying factor, the floor design could be considered acceptable for serviceability conditions.

The multiplying factors specified in BS 6472 are based on continuous vibrations, and are therefore appropriate for floors that are very heavily trafficked with walkers continually present. For less heavily trafficked floors, walking activities will produce intermittent vibrations; BS 6472 permits a cumulative measure of the floor response in these situations through the use of vibration dose values (VDVs). In these circumstances it can sometimes be shown that the floor would be acceptable, even when the response factor is greater than the multiplying factor appropriate for continuous vibrations. Although there are significant benefits to designers using the VDV approach, it has not often been used in design because of a lack of guidance on its application. To remedy this, the new SCI Publication on floor vibrations[3] (SCI P354) provides guidance on the use of this assessment technique, which will benefit designers in both the short- and long-term as, because of its greater reliability, there are moves to only permit VDVs in future Standards on vibrations. This Advisory Desk note introduces the VDV method and presents an example of its use.

What is a VDV and where does it come from?

As perception and discomfort varies between humans, no exact limit can be imposed that will guarantee that the floor response will not give rise to adverse comments. Instead of imposing absolute values for human acceptance to vibrations, BS 6472 and other international Standards on vibration specify limits which will attract 'a low probability' of adverse comment. For cases when the vibrations are continuous BS 6472 specifies the multiplying factors given in Table 1 (the larger the value, the more active the environment).

It is unlikely that, during a typical day, vibrations caused by walking will occur continuously, and indeed BS 6472 gives alternative values for very short-term vibrations that can occur up to 3 times per day. However, it may be the case that response factors between the two multiplying factor limits (for continuous vibration and impulsive vibration) occur more frequently than 3 times per day, but less often than continuous, and in these cases an alternative method of establishing acceptability is required.

Place	Time	Multiplying factor for exposure to continuous vibration 16h day 8h night	Impulsive vibration excitation with up to 3 occurrences
Critical working areas (e.g., hospital operating theatres)	Day	1	1
	Night	1	1
Residential	Day	2 to 4	60 to 90
	Night	1.4	20
Office	Day	4	128
	Night	4	128
Workshops	Day	8	128
	Night	8	128

Table 1 - Multiplying factors specified in BS 6472 for 'low probability of adverse comment'.

In SCI P354, the concept of a vibration dose value (VDV) is introduced as a companion to the response factor approach. This enables a designer to class a floor with a response factor between the limits given for continuous and impulsive vibration in Table 1 as acceptable based on the intermittency of the occurrence. Again, limits are given in BS 6472 (and reproduced in ISO 10137[4]), which are developed from the following equation:

$$VDV = 1.4 a_{w,rms} \sqrt[4]{T} \quad (1)$$

where:

T is the total duration of the activity during an exposure period (16 hr day, 8 hr night) [s]

$a_{w,ms}$ is the frequency-weighted rms acceleration [m/s²]

As an example of the calculation process, a floor with a response factor of R = 4 (which corresponds to a weighted acceleration of 0.02 m/s², as described in P354) occurring continuously over a period of 16 hours is considered. Inserting these values into Equation (1) gives:

$$VDV = 1.4 \times 0.02 \times \sqrt[4]{16 \times 60 \times 60} = 0.434 \quad (2)$$

Similarly for a response factor of R = 2,

$$VDV = 1.4 \times 0.01 \times \sqrt[4]{16 \times 60 \times 60} = 0.217 \quad (3)$$

These values correspond exactly with those given in BS 6472 (see Table 2, below) for 'a low probability of adverse comment' – the same definition as used for the multiplying factor in Table 1.

It should be noted that these VDV limits are not applicable to critical working areas, such as operating theatres and precision laboratories, as even a single high response in these areas could have damaging consequences.

Using VDVs

Typically a VDV analysis can be performed after the response factor has been obtained, so if a floor does not meet the requirements for continuous vibration (by comparing R to the multiplying factors in Table 1), the designer can proceed to the simple calculation required to determine the VDV. Although the limits for VDVs are obtained from Equation (1), research by Ellis[5] suggests that a smaller coefficient is required as response from walking activities is not as simple as the model used in BS 6472; hence, the following equation can be used in design:

$$VDV = 0.68 a_{w,rms} \sqrt[4]{T} \quad (4)$$

and, by substituting $T = n_a T_a$ and rearranging:

$$n_a = \frac{1}{T_a} \left[\frac{VDV}{0.68 \times a_{w,rms}} \right]^4 \quad (5)$$

where:

T_a is the duration of an activity (for example, the time taken to walk along a corridor) [s]

n_a is the number of times the activity will take place in an exposure period.

$a_{w,rms}$ is the frequency-weighted rms acceleration [m/s²]

For example, if a response factor of R = 10 ($a_{w,rms}$ = 0.05m/s²) is obtained for walking along a 30m corridor (which takes about 20 seconds to traverse), and a maximum VDV of 0.4 is required:

$$n_a = \frac{1}{20} \left[\frac{0.4}{0.68 \times 0.05} \right]^4 = 958 \quad (6)$$

→

Place	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
buildings 8 h night	0.13	0.26	0.51

Table 2 - Vibration Dose Value limits ($m/s^{1.75}$) specified by BS 6472.

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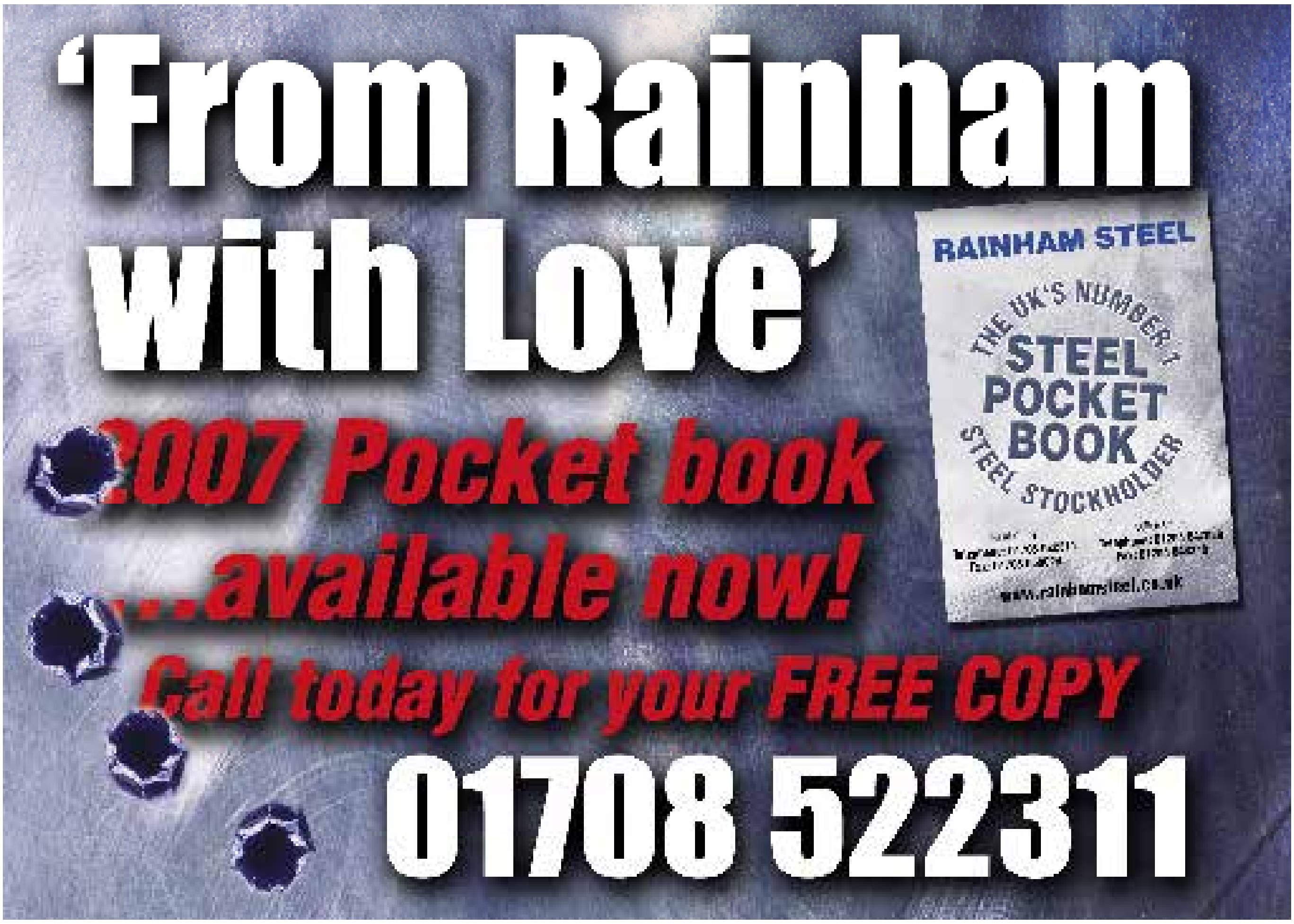

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New Flyover at Croydon

The viaduct portion of the new High Street–Old Town flyover in the Greater London Borough of Croydon provides an interesting use of Preflex beams for this type of structure. The preflexed section over the high street has four spans of steelwork, ie 85ft and 87ft long comprising nine beams each, and two 56ft incorporating 11 and 13 beams respectively. On each side are shorter spans using prestressed concrete standard bridge beams.

A feature of the construction is the inclusion of the support crossheads within the depth of the deck, this being achieved by supporting twin universal beams on stools carried on special bearings. The longitudinal beams are bolted to these transverse beams with high strength friction grip bolts and the whole encased in concrete to the same thickness as the external deck beams, ie 47½in.

The choice of preflex beams for this particular project was influenced by several factors, one of particular importance being the need for quick construction so as to avoid as much possible interference with the dense pedestrian and vehicular traffic. The 18 longer beams were in fact transported from a railhead about two miles from the site and placed in position in only 18 hours, some of the beams taking as little as 20 minutes to fix. This work was undertaken in May of this year (1967) during a Saturday night and Sunday when the road could be closed to traffic. The beams for the two shorter spans were placed in position during normal working hours.

The beams are of shallow depth and this was another contributory factor to their choice because the depth of construction in these four spans had to be kept to a minimum in order to maintain clearances over the highway. Erection was simplified and speeded by the fact that due to their comparative lightness the beams could be conveniently handled by a single mobile crane.

Engineer for Croydon Flyover:
H. Marcus Collins, C.Eng, MICE, Borough Engineer Croydon Borough Council.
Consulting Engineers:
Walter C. Andrews and partners.

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Continued from previous page

This means that the corridor can be traversed 958 times per day and correspond to 'a low probability of adverse comment'. Taking a typical office day as 10 hours, if the floor is traversed less than once every 38 seconds on average, the floor can be considered satisfactory. Note that if R = 8 is obtained, this becomes less than once every 15 seconds.

The VDV approach also provides an insight into why the high response of lightweight traditional timber joisted floors is tolerated by occupants in residential dwellings, compared to the levels that would be deemed acceptable in busy open-plan office environments.

How often will a floor be traversed?

Unfortunately no guidance exists to define the frequency with which a floor will be traversed, as there are many factors that will affect it. For an office, for example, it will depend on the size and density of the office, the type of work being undertaken and the location of utilities such as toilets, drinks machines, printers, etc. relative to the desks (among other factors) - a large office where individuals work independently may have less activity than a small office where there is a large amount of cooperation on projects. As such, discussion with architect and client will be required to assess the acceptability of a floor in these circumstances.

Conclusions

VDV analysis provides an improved means of assessment for floors where vibration may not be continuous, and so can be subject to more relaxed criteria. To enable use of the VDV method, the floor response should not be specified in terms of a response factor, but in terms of a probability of adverse comment, with low probability being the norm.

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4. ISO/DIS 10137 Bases for design of structures – Serviceability of buildings against vibration International Organisation for Standardization, Paris, 2006
5. ELLIS, B.R. Serviceability evaluation of floor vibration induced by walking loads The Structural Engineer 79(21), November 2001, pp 30-36

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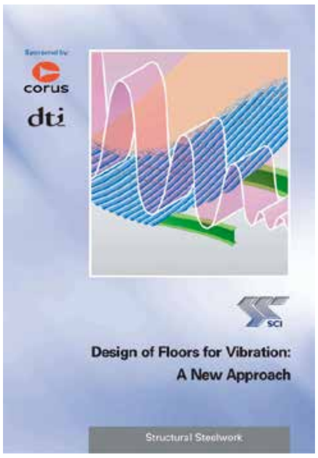

Note: The previous design guides by the SCI entitled 'Design guide on the vibration of floors' (popularly referred to as P076) and 'Design guide on the vibration of floors in hospitals', are now withdrawn

Design of Floors for Vibration: A New Approach

Catalogue Reference: P354
Authors: A L Smith, S J Hicks and P J Devine

This publication provides guidance for vibration design of all steel-framed floor and building types.

Vibration measurements taken over the last 10 years on steel-framed floors have been used to develop new design methodology in this publication. It extends the previous guidance to new forms of construction (such as *Slimdek*®) and special floors (such as dance floors, hospital floors, light steel floors etc.). It includes:

- The human perception of vibration and the criteria by which it is measured.
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- NHS performance standard for hospitals, according to Health Technical Memorandum 2045.
- A set of worked examples, illustrating the design procedures.

Please refer to the Technical Article on page 30 for further details.

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BCSA is the national organisation for the steel construction industry. Details of BCSA membership and services can be obtained from Gillian Mitchell MBE, Deputy Directory General, BCSA, 4 Whitehall Court, London SW1A 2ES
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The Register of Qualified Steelwork Contractors

BUILDINGS SCHEME

Applicants may be registered in one or more categories to undertake the fabrication and the responsibility for any design and erection of:

- **A** All forms of steelwork (C-N inclusive)
- **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

Company Name	Telephone	A	C	D	E	F	H	J	K	L	M	N	S	QA	Contract Value (1)
ACL Structures Ltd	01258 456051				●	●	●				●				Up to £2,000,000
Advanced Fabrications Poyle Ltd	01753 531116					●	●	●	●	●	●			●	Up to £400,000
Allslade PLC	023 9266 7531				●	●	●			●					Up to £4,000,000
Atlas Ward Structures Ltd	01944 710421	●	●	●	●	●	●	●	●	●	●			●	Up to £6,000,000*
B D Structures Ltd	01942 817770			●	●	●	●								Up to £2,000,000*
B & K Steelwork Fabrications Ltd	01773 853400		●		●	●	●	●	●		●			●	Up to £4,000,000*
A C Bacon Engineering Ltd	01953 850611				●	●	●								Up to £800,000
Ballykine Structural Engineers Ltd	028 9756 2560				●	●	●	●				●		●	Up to £2,000,000
Barrett Steel Buildings Ltd	01274 266800				●	●	●							●	Up to £6,000,000
Billington Structures Ltd	01226 340666	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000
Bison Structures Ltd	01666 502792			●	●	●	●							●	Up to £2,000,000
Border Steelwork Structures Ltd	01228 548744		●		●	●	●					●			Up to £2,000,000
Bourne Steel Ltd	01202 746666	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000
Brooksby Engineering	01707 872655					●		●	●	●	●				Up to £200,000
Butterley Ltd	01773 573573	●	●	●	●	●	●	●	●	●	●	●		●	Up to £3,000,000*
Cairnhill Structures Ltd	01236 449393		●			●	●	●		●	●			●	Up to £1,400,000*
Caunton Engineering Ltd	01773 531111		●		●	●	●	●			●	●		●	Up to £6,000,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000*
Compass Engineering Ltd	01226 298388		●		●	●	●		●						Up to £2,000,000
Conder Stuctures Ltd	01283 545377			●	●	●	●							●	Up to £6,000,000
Leonard Cooper Ltd	0113 270 5441		●			●	●		●		●			●	Up to £800,000
Costruzioni Cimolai Armando SpA	01223 350876	●	●	●	●	●	●	●	●	●	●	●		●	Up to £6,000,000
Curtis Engineering Ltd	01373 462126					●									Up to £800,000
Frank H Dale Ltd	01568 612212			●	●	●								●	Up to £6,000,000
EAGLE Structural Ltd	01507 450081				●	●	●	●	●	●					Up to £400,000
Elland Steel Structures Ltd	01422 380262		●	●	●	●	●		●					●	Up to £4,000,000
Emmett Fabrications Ltd	01274 597484				●	●	●								Up to £800,000
EvadX Ltd	01745 336413				●	●	●	●		●	●	●		●	Up to £1,400,000
Fairfield-Mabey Ltd	01291 623801	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000*
Fisher Engineering Ltd	028 6638 8521	●	●	●	●	●	●	●	●	●	●	●		●	Up to £6,000,000
Glentworth Fabrications Ltd	0118 977 2088					●	●	●	●	●	●	●			Up to £2,000,000
Graham Wood Structural Ltd	01903 755991	●	●	●	●	●	●	●	●	●	●	●			Up to £6,000,000
D A Green & Sons Ltd	01406 370585				●	●	●	●				●		●	Up to £3,000,000
William Hare Ltd	0161 609 0000	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000
Harland & Wolff Heavy Industries Ltd	028 9045 8456		●		●	●	●	●	●	●	●			●	Up to £6,000,000
James Bros (Hamworthy) Ltd	01202 673815				●	●	●	●				●		●	Up to £2,000,000
James Killelea & Co Ltd	01706 229411		●	●	●	●	●					●			Up to £6,000,000*
Meldan Fabrications Ltd	01652 632075		●		●	●	●	●	●		●			●	Up to £4,000,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●				Up to £2,000,000
Normanby Wefco Ltd	01427 611000		●				●	●	●		●			●	Up to £800,000
Nusteel Structures Ltd	01303 268112						●	●	●	●				●	Up to £2,000,000*
Oswestry Industrial Buildings Ltd	01691 661596				●	●	●		●		●				Up to £400,000
RSL (South West) Ltd	01460 67373				●	●	●				●				Up to £800,000
John Reid & Sons (Strucsteel) Ltd	01202 483333	●	●	●	●	●	●	●	●	●	●	●			Up to £6,000,000
J Robertson & Co Ltd	01255 672855									●	●		●		Up to £100,000
Robinson Construction	01332 574711		●	●	●	●	●							●	Up to £6,000,000
Roll Formed Fabrications Ltd	028 7963 1631				●	●	●	●		●	●	●		●	Up to £800,000
Rowecord Engineering Ltd	01633 250511	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000
Rowen Structures Ltd	01623 558558	●	●	●	●	●	●	●	●	●	●	●			Up to £6,000,000
SIAC Butlers Steel Ltd	00 353 502 23305		●	●	●	●	●	●				●		●	Up to £6,000,000
Severfield-Reeve Structures Ltd	01845 577896	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000*
Henry Smith (Constructional Engineers) Ltd	01606 592121		●	●	●	●	●	●							Up to £2,000,000
Traditional Structures Ltd	01922 414172			●	●	●	●	●	●			●		●	Up to £1,400,000
Warley Construction Company Ltd	01268 726020				●					●					Up to £400,000
Watson Steel Structures Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000*
Webcox Engineering Ltd	01249 813225				●	●	●				●				Up to £400,000

Notes (') Contracts which are primarily steel but which may include associated works. The steelwork contract for which a company is pre-qualified for the Scheme is intended to give guidance on the size of steelwork contract that can be undertaken; where a project lasts longer than a year, the value is the proportion of the steelwork contract to be undertaken within a 12 month period.

(*) Where an asterisk appears against any company's classification number, this indicates that the assets required for this classification level are those of the parent company.

BRIDGEWORKS SCHEME

Based on evidence from the company's resources and portfolio of experience, the Subcategories that can be awarded are as follows:

FG Footbridges and sign gantries
PT Plate girders [>900mm deep], trusswork [>20m long]
BA Stiffened complex platework in decks, box girders, arch boxes.
CM Cable stayed bridges, suspension bridges, other major structures [>100m]
MB Moving bridges
RF Bridge refurbishment
X Unclassified

Applicants may be registered in more than one sub-category.

Company Name	Telephone	FG	PT	BA	CM	MB	RF	X	Contract Value (1)
Allerton Engineering Ltd	01609 774471	●	●	●	●	●	●		Up to £1,400,000*
Briton Fabricators Ltd	0115 963 2901	●	●	●			●		Up to £800,000
Butterley Ltd	01773 573573	●	●	●	●	●	●		Up to £3,000,000*
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●		Above £6,000,000*
Costruzioni Cimolai Armando SpA	01223 350876	●	●	●	●	●			Up to £6,000,000
Fairfield-Mabey Ltd	01291 623801	●	●	●	●	●	●		Above £6,000,000*
Harland & Wolff Heavy Industries Ltd	028 9045 8456	●	●	●	●		●		Up to £6,000,000
Interserve Project Services Ltd	0121 344 4888						●		Above £6,000,000
Interserve Project Services Ltd	020 8311 5500		●	●		●	●		Up to £400,000*
Meldan Fabrications Ltd	01652 632075	●	●	●	●	●	●		Up to £4,000,000
'N' Class Fabrication Ltd	01733 558989	●	●	●		●	●		Up to £1,400,000
Normanby Wefco Ltd	01427 611000	●	●	●			●		Up to £800,000
Nusteel Structures Ltd	01303 268112	●	●	●	●				Up to £2,000,000*
P C Richardson & Co (Middlesbrough) Ltd	01946 727119	●					●		Up to £6,000,000
Rowecord Engineering Ltd	01633 250511	●	●	●	●	●	●		Above £6,000,000
Taylor & Sons Ltd	029 2034 4556	●	●	●	●	●	●		Up to £800,000
Watson Steel Structures Ltd	01204 699999	●	●	●	●	●	●		Above £6,000,000*

Notes (') Contracts which are primarily steel but which may include associated works. The steelwork contract for which a company is pre-qualified for the Scheme is intended to give guidance on the size of steelwork contract that can be undertaken; where a project lasts longer than a year, the value is the proportion of the steelwork contract to be undertaken within a 12 month period.
(*) Where an asterisk appears against any company's classification number, this indicates that the assets required for this classification level are those of the parent company.

SCI Members

SCI (The Steel Construction Institute) develops and promotes the effective use of steel in construction. It is an independent, membership-based organisation. Membership is drawn from all sectors of the construction industry; this provides beneficial contacts both within the UK and internationally. Its corporate members enjoy access to unique expertise and free practical advice which contributes to their own efficiency and profitability. They also recieve an initial free copy of most SCI publications, and discounts on subsequent copies and on courses. Its multi-disciplinary staff of 45 skilled engineers and architects is available to provide technical advice to members on steel construction in the following areas:

- Technical Support for Architects
- Bridge Engineering
- Building Interfaces
- Civil Engineering
- Codes and Standards
- Composite Construction
- Connections
- Construction Practice
- Corrosion Protection
- Fabrication
- Health & Safety — best practice
- Information Technology
- Fire Engineering
- Light Steel and Modular Construction
- Offshore Hazard Engineering
- Offshore Structural Design
- Piling and Foundations
- Specialist Analysis
- Stainless Steel
- Steelwork Design
- Sustainability
- Vibration

Details of SCI Membership and services are available from:
Pat Ripley, Membership Manager, SCI (The Steel Construction Institute), Silwood Park, Ascot, Berks.
Telephone: +44 (0) 1344 636509 Fax: +44 (0) 1344 636570
Email: pat.ripley@steel-sci.com Website: www.steel-sci.com

SCI would like to welcome the following new Corporate Member:

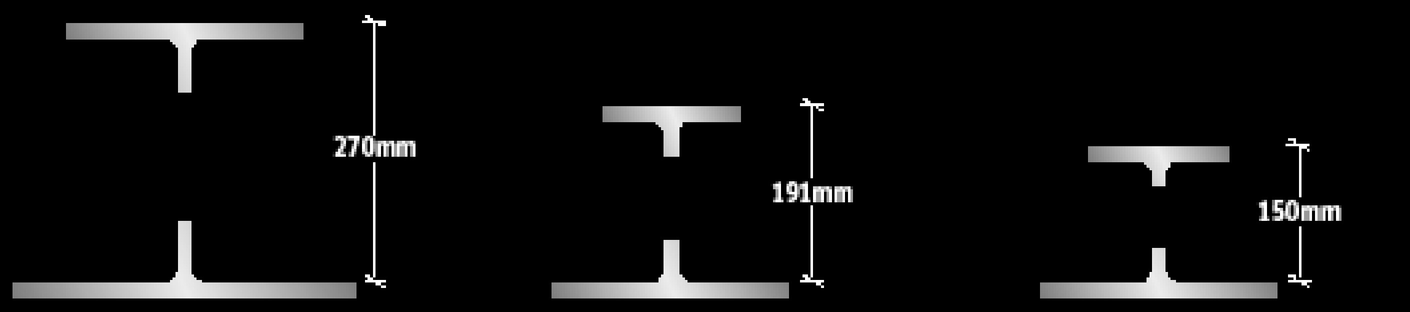
IRELAND
Metcon

RUSSIA
Steel Construction LLC

UK
Hockley & Dawson Consulting Engineers Ltd

All full members of the BCSA are automatically members of SCI. Their contact details are listed on the BCSA Members pages.

SHALLOW.. SHALLOWER.. ULTRA SHALLOW



SHALLOW..		SHALLOWER..		ULTRA SHALLOW	
USFB®	294 x 254/368 x 154 kg/m	USFB®	206 x 152/254 x 55 kg/m	USFB®	165 x 152/254 x 51.5 kg/m
Span	8.5m	Span	5.5m	Span	4.3m
Centres	5.3m	Centres	3m	Centres	2.5m
Top Tee	254 x 254 x 132	Top Tee	152 x 152 x 37	Top Tee	152 x 152 x 30
Bottom Tee	356 x 368 x 177	Bottom Tee	254 x 254 x 73	Bottom Tee	254 x 254 x 73
Project	Ormeau Road, Belfast	Project	Dawson Place, London	Project	The Bridge, Perth

Now you can achieve floor depths normally associated with concrete, but with the economy, flexibility and short lead-times of steel.

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FREE DESIGN SERVICE
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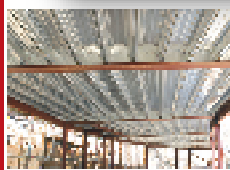
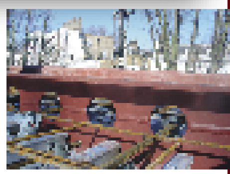
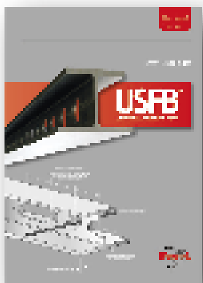
USFB® and Pre-cast Construction

USFB® and Metal Deck Construction







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☐ FREE Design Service ☐ Project Design Meeting with a Westok Advisory Engineer ☐ USFB® Design G[redacted] state no. of copies req[redacted]

☐ Technical Seminars - 'Cellular Beams & USFB®s - Applications & Design'

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