NOVEMBER/DECEMBER 2005 VOL 13 NO 10

NSC

NEW STEEL CONSTRUCTION

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Steel wins cost comparison
New standards set in healthcare
Health and leisure in Burnley

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NSC

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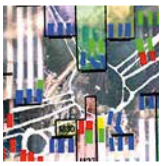


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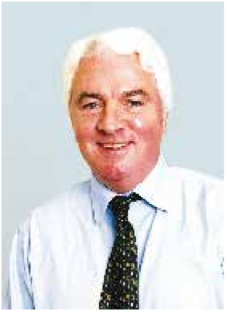
The British Constructional Steelwork Association Ltd

The Steel Construction Institute

Steel gives hospitals 'wow' appeal



Nick Barrett - Editor

Steel has been making good inroads in the healthcare market over the past few years, a trend which can only be reinforced by the results from floor vibration tests which have just been carried out (see News). The research completely scotches suggestions made by rivals that steel-concrete composite floors would have to be uneconomically deep to attain the required vibration performance as people walk near sensitive areas like operating theatres.

Test results show that composite floors not only meet the requirements, but do so easily and with a large margin to spare. Concrete floors are sometimes struggling to match the performance that can be expected of steel; we have heard recently that the initial vibration performance of concrete is not always maintained over time, as concrete creep has an adverse impact on performance. There are no such worries over composite floors.

Private sector healthcare providers are cottoning onto the benefits of steel, as you can read in our article on the privately financed Independent Sector Treatment Centre at Halton General Hospital in Cheshire. The need to fast track this health provision meant that there was effectively no alternative to steel.

In the mainstream National Health Service there are a large number of steel framed hospitals and treatment centres being designed or constructed. Even where steel has not been chosen for the main structural frame, as with the Evalina Children's Hospital which we write about in this issue, steel is being selected to support architects' ambitions for more pleasant and welcoming, even dramatic, healthcare buildings. Using steel at Evalina allowed a hospital to be created which, as the children themselves said, doesn't feel like a hospital, which can be a crucial factor in successful medical treatment for children. And as long as the floors are made of steel, they can jump up and down on them as much as they like.

Time to practice sustainability

Launch of the Steel Construction Sustainability Charter at the Steel Construction Conference this month could not have been better timed. There is a groundswell of opinion among clients across the public and private sectors that it is time the construction industry adopted sustainable practices, and the industry needs to be able to prove that it is doing so.

Corporate social responsibility is behind the demand of some clients for sustainable buildings. The business parks sector for example sees the change partly in a growing demand for edge of town rather than out of town locations. New regulations on energy certification and the Part L Building Regulations are affecting all buildings.

Another drive may be about to come from the Olympics, as Arup Director Michael Manning warned steel stockholders recently (see News). Government and the authorities involved in the Olympics see the Games as an opportunity to drive sustainability forward and the entire supply chain can expect to be asked questions which they might feel uneasy about answering. Fortunately, the steel sector has been carrying out the necessary groundwork in these areas for some years and solutions are available. Signing up to the Charter will be one way of ensuring that you know what to do to be a sustainable supplier.

Steel-framed hospital floors 'comfortably meet vibration limits'

New tests on floors in recently-built steel framed hospitals have demonstrated that they comfortably meet the NHS requirements on vibration response.

The tests emphatically refute an earlier study published in Concrete Quarterly which suggested composite steel deck floors would have to be substantially deeper than a flat slab or post-tensioned concrete floor to meet the criteria of Health Technical Memorandum 2045.

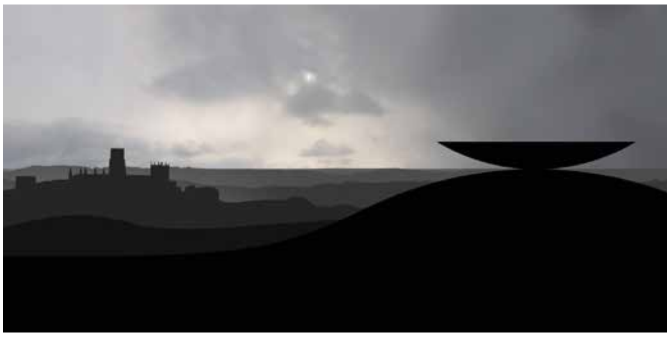
Results, reported more fully in this issue of NSC (page 20), show that composite floors in four hospitals with an overall slab depth of 175mm–337mm outperform the requirements by a factor of between two and four. In a fifth, an 80mm screed could have been omitted and the slab itself reduced from 335mm to 240mm and its response factor would still have been acceptable.

Dr Stephen Hicks, the Steel Construction Institute's Manager for Building Engineering, said: "The implications are that the floors in hospitals don't have to be designed any differently from floors in buildings for the commercial sector. On the basis of these measurements there's no particular need to do anything special to achieve good vibration response factors."

The hospitals tested include the recently completed Sunderland Royal Hospital (NSC June 2005).

Dr Hicks said that the 15m x 75m floor used for theoretical comparisons in the Concrete Quarterly study was not particularly representative of a hospital.

Artistic super bowl set to grace Durham skyline



Durham County Council has revealed proposals for Sky Bowl, a 15m diameter steel structure and visitor attraction designed by Swedish artist Pal Svensson that would change the skyline of the city. Support has been expressed from sources as diverse as the Bishop of Durham and local trade union leaders and an exhibition was held last month to gauge public reaction. The bowl would be constructed in weathering steel externally, with an interior of polished stainless steel to reflect the sky. Each section of the outer shell will incorporate artwork from a different County Durham community.

The last remaining section of the old Bishop's Bridge awaits lowering and dismantling when the newly launched structure is lowered onto its permanent supports

Bishop's Bridge deck launch completed

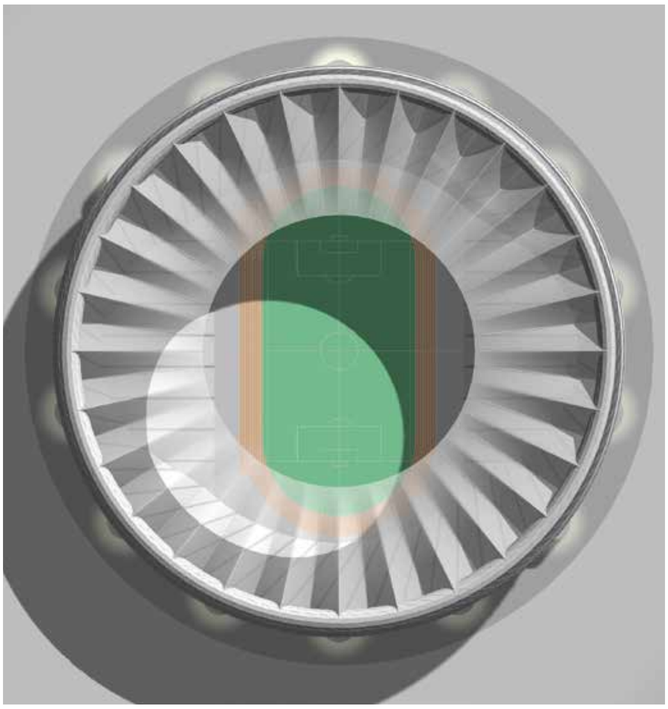
The second and final deck launch of Westminster City Council's new Bishop's Bridge has been carried out by Hochtief Construction. The 74m launch was carried out incrementally during nightly rail possessions in September to get the steel deck across platforms one to 10 of Paddington Station and on to its new southerly abutment.

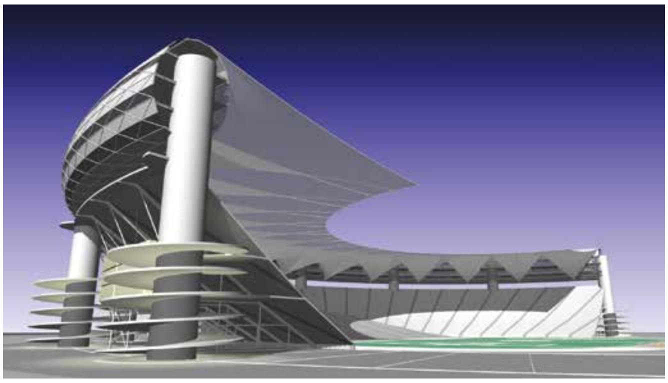
Hochtief is carrying out a £32M bridge and road construction project for Westminster replacing an old brick and cast iron structure with a wider and stronger four-span steel composite bridge. Cleveland Bridge is steelwork contractor. Westminster's project manager is Capita Symonds and Cass Hayward & Partners Hochtief's superstructure designer.

The next stage involves jacking the deck down from temporary steel trestles on to the permanent supports. The last remaining section of the old structure, a 40m steel Parker truss – which was previously jacked up 10m clear of where the new deck has been launched – will then be lowered on to the new structure and taken away to be dismantled.

The new bridge was launched over platforms one to 10 of Paddington Station during night time track possessions

Plan for re-usable Olympic stadium revealed





A radical plan to make the main 2012 Olympic stadium fully relocatable is to be put forward by a UK architect when the Olympic Delivery Authority seeks tenders for the detail design contract next month.

The fully-costed design has been developed by former Arup Associates Head of Design James Burland and structural engineer Mike King, an Associate of Ove Arup & Partners. Watson Steel Structures provided specialist design input. Burland and King previously designed the City of Manchester Stadium.

Mr Burland, who now heads his own firm BurlandTM, said the idea fits in with the emphasis on legacy in the 2012 London Olympic bid. The ability to re-erect the stadium elsewhere opens up the potential to hold a future Olympics in Africa, where few countries could afford the investment normally associated with staging the Games.

He said: "We will put in a bid for the 2012 Games when the contract for designing the stadium goes out to tender."

The stadium would be circular in plan. Its main roof structure would consist of a steel diagrid compression ring supported on tubular-cored structures which would also form the basis of Manchester stadium-style entrance ramps. Roof covering would be fabric. The compression ring would be big enough to provide 29,000m^2 of offices and VIP and media accommodation.

Seating terraces would be formed by repetitive segmental framed structures which would be constructed outside the stadium and slid into their final position. They would be made up of steel sections no longer than 12m.

The 80,000-seat stadium has been costed by EC Harris at just £120M. After the Games, the infrastructure for the stadium would allow mixed use development on the vacant site.

The indicative design for the stadium in the Candidate Document on which London's winning bid was based is for an 80,000-seat stadium which could be reduced in capacity to 25,000 after the Games. But critics have cast doubt on the practicality of the plan or the feasibility of building the stadium for the budgeted £250M.

Swale Crossing nears completion

Fairfield-Mabey is close to completing erection of the steel superstructure of the £40M Swale Crossing in Kent.

Managing Director Dr Peter Lloyd said the steelwork was running ahead of schedule and was expected to be completed in December.

The 1270m composite-deck steel plate girder viaduct has a 92.5m main span which is 29m above water level.

Fairfield-Mabey has already completed launching most of the bridge girders into place in three phases. An open day last month combining a site visit with presentations on the design and construction coincided with one of the launches and was attended by almost 100 guests.

The Swale separates the Isle of Sheppey from mainland Kent and at present is crossed only by a lift bridge which causes considerable delays to traffic when open. The new crossing is being built as part of a £100M design, build, finance and operate project to upgrade the A249 from the M2 at Stockbury to Sheerness docks being undertaken by Sheppey Route Ltd, a subsidiary of Carillion.

AROUND THE PRESS

Construction News
20 October
On Cleveland Bridge's annual results:
Cleveland President John Dale said: "The number of enquiries has increased significantly since last year. After Wembley, people stopped sending enquiries. But construction is still a tough game." The firm has won £30m worth of work in the past six months, including a £16.5M deal to upgrade the Tay Bridge in Dundee.

BBC News website
3 October
Global steel demand is expected to rise by between 4% and 5% in 2005 and 2006, according to industry body the International Iron and Steel Institute.

The organisation said this growth would continue to be fuelled by China, despite efforts by Beijing to try to cool its runaway consumption this year.

The IISI added that the picture was not perfectly clear and that global demand may be hit by high oil prices.

Building
30 September
Of all the facilities in the Human Genome Campus, the most record breaking in capacity and innovative in concept, is its nerve centre.

The computerised data centre takes the novel form of a three story, steel framed cube standing towards the rear of the main research building.

Construction News
6 October
On Heathrow Terminal 3's new car park:

Faced with the problem of building a rectangular car park on top of circular foundations, a rectangular transfer deck of structural steel girders up to 24 tonnes was placed between columns to transfer the load.

The thickness of the steel pieces of the transfer deck has the added advantage of fire rating the above ground roof structure of the Heathrow Express.

Government 'will use Olympics to push sustainability'

The Government will use the 2012 Olympics as a way of pushing the construction industry to adopt sustainable practices, a prominent UK structural engineer told the National Association of Steel Stockholders autumn conference.

Arup Director and Steel Construction Institute council member Martin Manning welcomed the BCSA's decision to introduce a sustainability charter, but added that the construction industry in general was reacting to the sustainability agenda rather than driving the discussion.

Mr Manning said that pronouncements on the Olympics and development of the Thames Gateway had convinced the design community that the Government and London Mayor Ken Livingstone were intent on applying the ideas of the London Sustainable Development Commission. This would be a logical extension of the whole approach adopted by the London 2012 bid, in which regeneration and legacy issues were pushed to the fore.

Mr Manning added: "I think this will change the industry dramatically for the good."

The LSDC's sustainable development framework document's objective is to "achieve environmental, social and economic development simultaneously", without improving one to the detriment of another. One of the principles of the framework is to "limit and deal with pollution, and use energy and material resources prudently".

Mr Manning said: "As an industry we're not very good at getting together and thinking about what sustainability means: instead we're waiting for the government to tell us." Speaking to NSC, he added: "I would be happier if we were out there contributing."

Arup is involved three projects for the 2008 Beijing Olympics: the main stadium, the aquatic centre and the media centre, involving 100,000t of steelwork apiece, as well as the airport extension. The designs, he argued, are intended to show that the Chinese industry's skills are the equal of the West's.

By contrast, the Stratford Olympic buildings would not be about demonstrating design flair for its own sake but "about doing the right thing".

Severfield-Reeve increases capacity

Severfield-Reeve Structures has invested in a range of new equipment as part of a refurbishment programme at its North Yorkshire plant.

The equipment includes two machines from FICEP: a high speed 1204 DTT CNC drilling and plasma coping line, and the company's second FICEP Tipo B25 for punching and plasma cutting large plates.

The investment programme has also seen the fabricator install a close-linked, Kaltenbach circular saw, an HDM1432 and a KDX1215 drilling line, at the plant near Thirsk. This follows the installation earlier this year of Kaltenbach heavy-duty HDM 1432, KC 1201 and KDX 1215 sawing, coping and drilling lines.

Severfield-Reeve Structures' 50-acre site is the largest steel fabrication facility in the UK, and now has eight production lines with the capacity to process 2,900 tonnes of steel a week.

New Steel Construction's website has been re-designed with a fresh, modern look which is more in tune with the design of the magazine. A key aim was to make the site easy to use, and new features include the ability to search both the current issue of NSC and the archives. There will be links to the site from the Corus, BCSA and SCI websites.

Rooney spotlights opportunities in Ireland

Steel companies are well placed to take advantage of opportunities in Northern Ireland, according to Dennis Rooney, chairman of the Development Fund for Ireland.

Mr Rooney, who is also chief executive of White Young Green Northern Ireland, told a recent BCSA/Corus seminar that, while prospects are mixed for the Northern Ireland economy as a whole, the prospects for the steel industry are good.

"The Northern Ireland economy has done exceptionally well in recent years," he said, "better in many areas than the overall UK economy. But it has some weaknesses, in particular overdependence on the public sector, which accounts for 60% of GDP per head, nearly one third higher than the UK average. We also have a weak private sector and are vulnerable to global market forces and competition like never before."

However, he said that the Government is committed to a £16 billion programme of investment in infrastructure over 10 years, which includes schools, hospitals, transport, water and tourism. "There are many large projects in the pipeline, many of which will be organised by the Strategic Investment Board, and most of which should have some work for your sector," Mr Rooney told the audience of steel specialists. "This infrastructure investment should in turn stimulate further work in the private sector."

He also urged the steel sector to look at opportunities in the Republic of Ireland, where "vigorous" infrastructure spending is set to continue for the next 10 years, claiming that the combined "North-South" spend is €110 billion.

Wales Millennium team honoured

Members of the design team for the Wales Millennium Centre received their award at the 2005 European Convention for Constructional Steelwork in Nice last month.

The award recognises the innovative use of steel in the building, which will play host to a range of productions including opera, ballet and musicals. The choice of steel challenged conventional wisdom that theatres are best constructed in reinforced concrete. "The Wales Millennium Centre demonstrates that steel has substantial benefits to design teams even when acoustic parameters are important," said the judges' citation.

Pictured L-R: Allan Collins, ECCS Executive Board Chairman; Keith Vince, Capita Percy Thomas; Iain Hill, Watson Steel Structures; Brian Peckham, Sir Robert McAlpine; Lorraine Bradley, Arup; Mike Dacey, Capita Percy Thomas; Jacques Huillard, ECCS President; Georges Gendebien, ECCS General Secretary.

CE marking to spread to steel fabrication

Steelwork contractors will be the next in line to have to get to grips with CE marking of their products. The European system for demonstrating that products meet all the requirements of European directives, introduced for steel sections on 1 September, will be extended to pre-loadable high strength friction grip bolts and fabricated steel from 2007. Non-preloadable bolts will follow a year later.

The move, part of a programme to cover all construction products, will have big implications for any company making products fabricated from steel, said British Constructional Steelwork Association Director of Engineering David Moore. It will apply to everything from volume produced lintels to cellular beams and one-off structures such as the component parts of a portal frame.

Though in the UK CE marking will not be mandatory, the alternative is to be able to produce, on demand, the relevant documentation to satisfy a Trading Standards Officer that the product in question meets all the relevant European standards.

To CE mark its products, a company will have to have in place a factory production control system assessed by a third party as well as a quality assurance system to ISO 9001. The third party will be a 'notified body' approved by the Office of the Deputy Prime Minister. The BCSA is studying the implications of the move and will be producing guidance for steelwork contractors shortly.

NEWS IN BRIEF

A consortium headed by contractor Impregilo has provisionally won the contract for the final design and construction of the **Strait of Messina bridge**. The bridge's 3,300m central span will be comfortably the world's longest. The final contact is expected to be signed by December. Cleveland Bridge is tipped to be a contender for supplying the deck.

SCI and Centre Technique Industriel de la Construction Métallique (CTICM) in France have announced the launch of a joint venture. **The Steel Alliance** will help to expand the steel market by offering innovative solutions for construction throughout Europe as well as practical, technical support and design guidance.

Construction of steelwork has began at the **Grand Arcade shopping centre in Wigan**. 5,000 tonnes of steel will be erected for main contractor Shepherd Construction. The 40,000m^2 scheme, which incorporates 35 retail units and a multi storey car park, is expected to be completed in Spring 2007.

Fabsec claims an industry first with the introduction of online instant messaging to support its design software. 'Instant Advisor', a live link available through *www.fabsec.co.uk*, gives engineers using its software immediate responses to technical enquiries and advice through on screen discussions.

Corus has released a new video, *"Strength from within"*, that showcases its sections business from steelmaking and rolling to end use. To order a copy in DVD or VHS format email *sylvain.baur@corusgroup.com*

Living Steel presents an opportunity for UK architects to provide a creative solution to the challenge of supplying cost-effective housing to a growing population. Winners will receive a prize of €50,000 and see their submission constructed in 2006. For more information visit *www.livingsteel.org*

Last chance to book for Steel Construction Conference

The Steel Construction Conference and Exhibition is only days away. Highlights of the event, to be held on 15 November at The Brewery, Chiswell Street in the City of London, will include the launch of the BCSA's Sustainability Charter by Professor Roger Plank of Sheffield University. Richard Elliott, Head of Construction at British Land, will give the keynote address on 'The Client's View of Sustainable Steel Construction'. The BBC presenter John Humphrys will chair a panel discussion on "The Future Construction Market". There will also be presentations on the Swale Bridge, Blackburn Hospital, the use of steel in residential buildings, and London's proposed Shard of Glass tower

Exhibitors will cover the whole of the steel construction market, including everything from steelwork contractors to suppliers of software, purlins, cladding, and corrosion protection.

Booking forms are available online at *www.steelconstruction.org*

Steel acclaimed in construction industry awards

One of the most technically demanding bridge strengthening projects ever undertaken in the UK emerged as the winner of the Major Projects category at last month's British Construction Industry Awards.

The £82.7M project to strengthen the Tinsley Viaduct (below left) in South Yorkshire took three years to complete and involved designing and fitting 114,000 tailor-made steel strengthening components.

The BCIA judges complemented the Tinsley team for completing the work on time, below tender cost and with an exemplary safety record.

Edmund Nuttall carried out the design and build contract for the Highways Agency, with Owen Williams as structural engineer and Cleveland Bridge UK as the specialist steelwork subcontractor.

Steel featured prominently in many other projects at the Awards, including the winner of the Small Civil Engineering Project category – the £2.97M reconstruction of two bridges carrying 10 sets of rail tracks in Battersea, south west London.

Here, Edmund Nuttall used two rail-mounted cranes to take out 360 tonnes of old bridge beams, 200 tonnes of brick rubble and 60 tonnes of timbers, and to put in 400 tonnes of new bridge deck sections.

Corus sponsored the Building Award for projects between £3M and £50M. The winner was the Jubilee Library, Brighton (below right), which also won the Prime Minister's Award for Better Public Buildings.

The winner in the Local Authority category was The Sage music centre in Gateshead, designed by Foster and Partners and Connell Mott MacDonald, and built by Laing O'Rourke at a cost of £70 million.

Corus's Alan Todd (left) and Culture Secretary Tessa Jowell present architect Rab Bennetts of Bennetts Associates (right) with the Building Award for Brighton Jubilee Library.

Described by the judges as "easily the winner from a group of excellent competing municipal entries", The Sage incorporates three adjacent – but acoustically isolated – performance halls wrapped in a stainless steel roof.

Diary

10 November
SCI Annual Dinner
Landmark Hotel, London. Guest speaker, John Sergeant
Further details: l.chamberlain@steel-sci.com

15 November
Steel Construction Conference and Exhibition
The Brewery, Chiswell Street, London EC1.
Organised by BCSA. Contact:
Gillian.mitchell@steelconstruction.org

17 November
British Stainless Steel Association Conference and Dinner
"Stainless Steel – Converting Opportunities into Reality"
Stratford Manor Hotel, Stratford-upon-Avon.
Contact Alison Murphy/Rakhee Jaria 0114 2671 260 or enquiry@bssa.org.uk

22–24 November
Civils 2005 Exhibition
Olympia, London
Visit the innovative double-deck Corus stand for the latest information on the full range of Corus products. Corus's Chris Dolling gives a free technical seminar on Weathering Steel Bridges on the 22nd.
Details: www.civils.com

Steel still winning on cost comparisons

Steel frames have been re-confirmed as the fastest and most cost effective solution for both commercial and residential apartment buildings by the latest Cost Comparison Survey, reports Nick Barrett.

The independently produced survey – by a team including Arup, Mace, Davis Langdon and the Steel Construction Institute – compares the relative costs of constructing two commercial buildings in steel and concrete, and also compares the relative costs of a multi-storey residential building. The conclusions also hold good for hospitals, education and retail buildings.

The survey, commissioned by Corus, has been updated regularly since first being produced in 1993, with the latest based on second quarter 2005 prices. The costs of fully-designed buildings were analysed, with Arup producing the concrete designs, the Steel Construction Institute the steel designs, Mace acting as project managers and Davis Langdon providing quantity surveyor input.

The buildings that were designed for the survey were a speculative office building in Manchester and a London head office building. The residential scheme was in outer London, a mixed-use scheme with retail on the ground floor and a basement car park.

The main cost difference between the steel-framed commercial buildings in the present survey and the last one at the end of 2003 is that the steel-framed option, including fire protection and floors, increased in price by between 9% and 20%. The overall building cost for a steel-framed building has risen in that time by between 5% and 9%. The price increase for a reinforced concrete frame in the same period was between 3% and 11% for frame and floors while the overall building cost rose by between 4% and 8%.

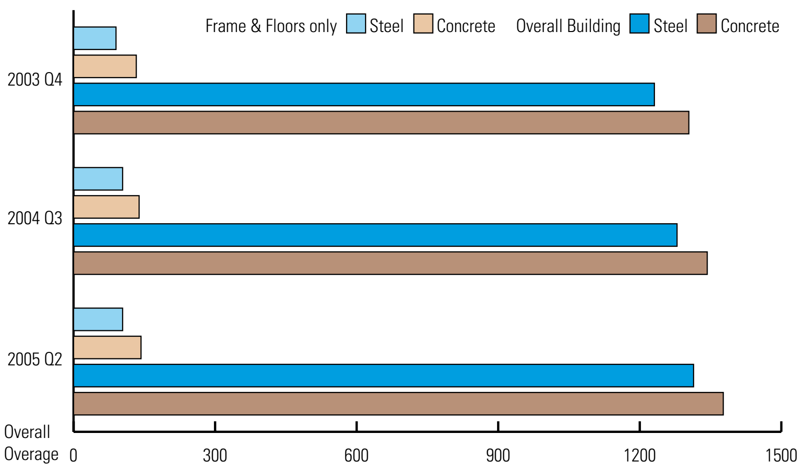
Despite this, steel remains the speediest and lowest cost option at typically between 3% and 5% below concrete in overall building cost terms.

In the multi-storey residential comparison frame and floor costs are found to be typically 13% to 15% of overall building costs. The survey shows that steel framed options are still typically 2% below concrete in overall building cost terms. The steel framed scheme has increased in price since 2003 by between 13% and 21% for frame and floor, while the overall building cost has risen between 8% and 10%. The reinforced concrete scheme has risen 19% for frame and floor while overall building cost is up 10%.

Corus General Manager Alan Todd said: "It is encouraging that the survey shows that steel is still ahead of the competition in terms of price alone, despite the price rises that have received so much publicity. When all the other benefits of steel are also considered, such as its speed and predictabilty of programme, the flexibilty of long spans and sustainability, the argument for choosing steel is as compelling as ever."

Department of Trade and Industry cost indices show steel solutions to be more competitive than 10 years ago; a steel frame and floor including fire protection is still typically 4% cheaper in real terms in 2005 than it was in 1995. Concrete frame and floor solutions on the other hand are typically 20% more expensive in real terms today than 10 years ago.

"The performance of the whole UK constructional steelwork industry over the past 25 years has been exceptional," says Mr Todd. "Back in 1981 the cost of a tonne of steel for a multi storey frame including fire protection was about £985, which would be £2,800 today if steel frame costs had kept pace with inflation. But the price for a tonne of fire protected structural steel in 2005 is in fact about £1,500. So in real terms structural steel costs about half what it did in 1981."



The updated competitive advantage graph – the gap shows that steel is still the cost effective option.

Steelwork demand strong across Europe

The popularity of structural steel has held up strongly throughout Europe, according to annual production figures delivered to the European Convention for Structural Steelwork. Geoffrey Taylor of Caunton Engineering casts his eye over the numbers.

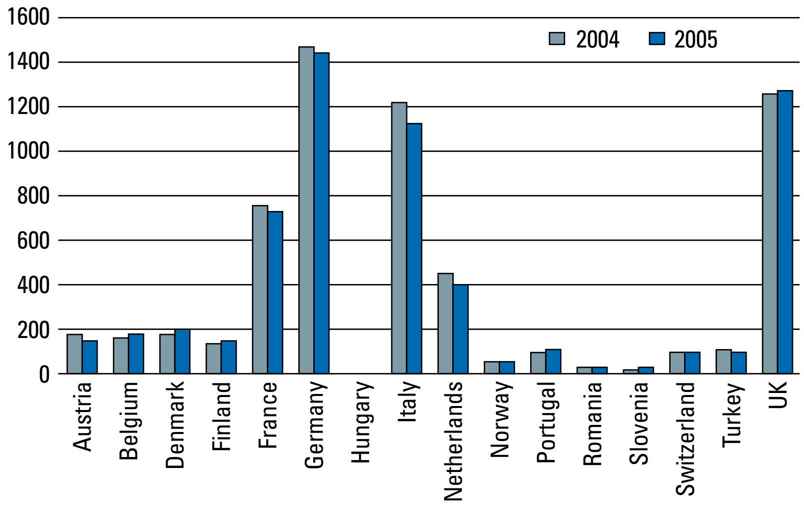
There was an air of anticipation when the 2005 European Statistical bulletin was issued at the ECCS Convention in Nice in September. How was the much publicised introduction of steel price rises in 2004 to affect the published figures?

The bulletin reports the most recent figures for production of steelwork for each country. European Convention for Constructional Steelwork members – BCSA represents the UK on ECCS – submit figures every year. In some cases the figures are an aggregate of their members' turnover; others are from their national statistics. Direct comparisons are therefore none too easy, but they are consistent so they allow for comparisons to be made.

It was comforting to read that the results were to show that in the majority of European countries the effects of the price rises had not seemed to affect sales of structural steel. The doom and gloom projected by some commentators did not materialise. Perhaps it was, inter alia, because the price of steel's most regular competing material, reinforced concrete, has also risen in cost and price?

The graph, illustrated here, clearly shows the outcome of the price rises has been marginal. Both Germany and Italy have experienced a fall in GDP and this explains much of what is shown in the figures exhibited. In Netherlands the industrial shed market has slowed and their figures reflect this. However, in the main the market shares in these three countries and the sales of structural steelwork in Europe in general have held up well. The German Steelwork Association also predicts that their slowdown, so pronounced since 2000, is bottoming out. That great structural steelwork engine that in the past has been Germany may well be roaring back before too long

Total European steel production for 2004 and 2005 in thousands of tonnes by country – ECCS members only.



Generally speaking the Nordic countries – in particular Norway with its oil and Denmark with its most successful wind-energy-generation industry manufacturers – are booming. The reported outcome in these countries is growth in residential building and in industrial buildings. Encouragingly, many countries are winning market share and growing sales of structural steelwork – particularly in eastern Europe. Statistics for Romania, Slovenia and Turkey make very good reading from a steelwork point of view. In the UK as many NSC readers will know, and in many other countries not mentioned here, the market is steady and established. Problems are occurring of course, with fresh challenges from competing materials, but these statistics do help to flag these up.

The bulletin itself is posted on the ECCS website *www.steelconstruct.com* for those who would like to read in more detail. The publication lists wherever possible the end use of steel per country by market sectors. It also supplies forecasts for production in these sectors. Also, again wherever possible, market share data by sector is recorded. In addition the Bulletin includes historic and forecast macroeconomic data relevant to the European constructional steelwork industry. The bulletin has been published for several years now, and for the fourth year we have included, where data has been available, the total production by country for every year since publication began. Around 15 or so members regularly contribute returns. This we estimate covers around two-thirds of European structural steelwork capacity.

As a member of the ECCS Promotion Management board, I was invited to introduce the contents of the bulletin to the Convention. My presentation in fact not only covered this, for I was then able to briefly explain Corus's strategy in growing the market share for steel in the high-rise residential market. As frequently reported in NSC, this has been such a great success so far, and it was good to be able to describe what had been accomplished and how Corus has achieved this. This may well encourage the many Convention delegates from other European countries in their efforts to increase their own market shares. Expanding the demand for the product of the steelwork industry throughout Europe is clearly beneficial for every one of us working within the structural steelwork community.

Children help create hospital with 'wow' factor

The new Evelina Children's Hospital in London sets new standards for design and patient care, as Margo Cole reports

FACT FILE
The Evelina Children's Hospital
Developer: *Guy's and St Thomas' NHS Foundation Trust*
Contruction cost: *£41.8m*
Architect: *Hopkins Architects*
Structural engineer: *Buro Happold*
Main contractor: *Gleeson*
Steelwork contractor: *SH Structures*

During the Victorian era hospitals, like most public buildings, were designed to inspire, impress and instill wonder and awe. We may argue now about the merits of their design in terms of modern clinical practices, but it is extremely rare to find a new hospital building that incorporates a genuine "wow" factor, as they did.

How refreshing it is, then, to see the completion of the Evelina Children's Hospital, a specialist unit of St Thomas' Hospital on London's South Bank. The building manages to be child-orientated while having extraordinary architectural merit and also enabling the highest possible standards of clinical practice to be achieved.

The Evelina's design is the result of a RIBA-hosted architectural competition instigated by Guy's and St Thomas's Charity in 1999 — the first ever such competition for a major healthcare facility. The charity, which dates back to the 16th century, has provided £50M of the £60M cost of the new hospital.

Having won the competition, a design team of Hopkins Architects and structural engineer Buro Happold entered into discussions with the client — Guy's and St Thomas' NHS Foundation Trust — its patients, staff and the local community to provide a hospital that, in the words of children being cared for at Evelina, "doesn't feel like a hospital".

Children have played a huge part in the design ethos, as well as in the details. Most children's wards in major hospitals are really adult facilities with the addition of a few toys and posters. Evelina is a genuine children's hospital, and children have been consulted on everything from the fundamental design to the food in the canteen.

One of their first requests was that the building should be airy and spacious and make them feel like they are outside. "That," says Buro Happold's project engineer Matthew Grant, "is how the conservatory came about."

The conservatory is the hub of the new hospital, a four-storey atrium running the entire length of the building and covered by a fully glazed, curved, steel-framed roof. It is a magnificent space that, by virtue of starting at the third floor, succeeds in its aim of bringing the outside — in the form of sky and trees from the adjacent park — right into the building. There is also access to a roof garden for patients well enough to venture outside.

The hospital's design consists of a simple L shaped section with the lowest three floors housing the most intensely serviced functions such as operating theatres, MRI scanner and outpatients. Huge light wells punched through from the third floor conservatory level bringing light into these deeper plan spaces. To the north three ward levels and an office space are stacked on top of each other, benefiting from the stunning views through the conservatory that sweeps from the southern edge up to the roof level.

The structure of the giant arched roof, which spans 20m in height and 18m in width, is a steel gridshell made from 273mm diameter circular hollow steel sections. Its curved design generates large horizontal forces, so the entire structure is tied back into the concrete frame of the main blocks both at third floor and roof level.

The Hospital

The Evelina Children's Hospital can accommodate 140 in-patients, 20 of them in intensive care beds. The beds are in clusters of between four and eight, and each is accompanied by a drop-down bed for a parent or relative.

Each floor of the hospital has a theme based on the natural world, with signage and names designed to match the themes. They are — from the ground up — Ocean, Arctic, Forest, Beach, Savannah, Mountain and Sky. In-patient beds are on levels three to five (Beach, Savannah and Mountain), with each area named after an animal that could be found in that part of the natural world (Camel, Crab and so on). Artwork reinforces these themes.

The Conservatory (on Beach level) houses a school, café, performance areas and Radio Lollipop, the hospital radio station. It is expected that patients well enough to get out of bed will meet their visitors in this area, and there will also be performances and opportunities to meet celebrity visitors. Children unable to leave their wards can look down on the Beach, as all in-patient bed areas face the Conservatory.

The Evelina has been designed to incorporate almost all the specialist services that might be needed, so it is only on rare occasions that children will have to go to the adult hospital next door.

Most of the funding for the hospital has come from Guy's and St Thomas' Charity, which supports hospitals in Lambeth and Southwark. The Charity also administers the appeal that is raising money to supply specialist equipment to the hospital. One per cent of all the money donated by the Charity has been spent on art. For more information on the appeal go to www.evelinaappeal.org.

Far left: Wards look into the conservatory and over a park beyond
Left: Three levels below the atrium house theatres and scanners
Above: The atrium is a response to children's wishes for an airy and spacious building

"The arched roof is trying to push outwards, so it is tied back into the concrete frame using large tie members," explains Mr Grant. But the connections are pinned joints, so the only loads are the horizontal and vertical thrust.

All the loads that are transferred into the concrete frame go back to four stability cores.

On most of the conservatory roof the glazing follows the curve. However, the lower portion on the south side has vertical glazing, allowing the curve of the structure to continue externally, creating a walkway. At the intersection of the vertical glazing and the curved roof there is a hinge detail that allows the vertical portion of the glazing to move independently of the rest of the roof. "Without this articulating joint the load would be going through the glazing support," explains Mr Grant.

At each of the conservatory's side elevations a row of vertical aerofoil-shaped trusses takes the wind loading and provides horizontal restraint for the glazed facades.

"The whole design concept of this roof was to design something that could be built 20m up in the air and with limited crane access," says Mr Grant.

Steel fabricator SH Structures was called in during the process to advise on buildability. "We spent a lot of time talking to the industry about how we were going to build this," says Mr Grant. "It acted as a reality check so the design team didn't go off on one tack and the industry on another. The design of the roof had to take into account building tolerances because it was all going to be built on site."

The eventual construction method agreed between the design team, SH Structures and the main contractor Gleeson, was to build the gridshell as a series of vertical trusses. Steel sections arrived with two pieces linked — like a wishbone — by a cruciform joint. Another two sections were then fitted to the joint on site and welded into position, with this process continuing to the full height of the building before starting on the next truss along.

The gridshell was not stable until the whole frame was in place, so the entire floor area was scaffolded out during construction to support the steelwork in the temporary condition. The scaffolding then stayed in place while the glazing was fixed.

SH Structures manufactured the steel to cope with anticipated deflections, and the glazing was manufactured to fit the frame in its deflected state.

A key buildability issue was managing the interface between the steel roof and the concrete frame. "We knew we would have to take all the building tolerances out with the steel," explains Mr Grant. "With steel construction you can achieve very tight tolerances but with concrete they are a lot wider, so we had to accommodate this within the connections."

Each of the main pinned connections at the top of the roof is fixed to a steel plate that is itself attached to another steel plate cast into the concrete. This method enabled both horizontal and vertical alignment to be adjusted to take account of the finished concrete levels.

The concrete frame itself is of flat slab construction, so large steel beams were cast into the slabs to accommodate the thrust from the gridshell structure.

Although predominantly concrete-framed, the lower section of the hospital building does incorporate a major piece of steel construction in the form of a transfer truss at lower ground floor level. The structure is needed to create an accessway large enough to allow fire appliances to get beneath and around the building. This could only be achieved by removing two columns from the 9m grid and spanning the gap with a tubular steel truss, which supports the load from eight storeys of hospital above.

"The truss is one full storey height deep, and it is working very hard," says Mr Grant. "There are 250 tonne point loads coming down to each of the third points, which is higher load than you get on most bridges."

The truss weighs in the order of 20 tonnes, and Gleeson had to bring in the UK's largest portable crane to lift it into place. Large steel columns encased in the walls either side of the opening, and which are tied back into the reinforced concrete core wall, provide support for the truss.

Although the building has been finished since March, fitting out took a further six months. This not only gave time for specialist equipment — such as the MRI scanner — to be installed, but also for large amounts of specially-commissioned artwork to be fixed into place. The first children themselves were admitted the Evelina Hospital in mid-October.

Early delivery for Kettering logistics park

FACT FILE

Developer: *ProLogis*
Main contractor: *Winvic Construction*
Architect: *Stephen George & Partners*
Structural Engineer: *Capita Symonds*
Steelwork contractor: *Atlas Ward Structures Ltd*
Steelwork tonnage: *1250t*

Sheds just keep getting bigger. This major new East Midlands warehouse will soon be joined by one twice as big.

The eight-bay portal frame is a total of 235m wide and will provide 40,800m².

Demand for large distribution warehouses in the UK shows no sign of abating. The East Midlands and Northamptonshire in particular are the focus for development of a whole swathe of logistics parks. These include the DIRFT logistics park and rail freight terminal at Daventry *(News last month)* while multinational distribution services giant ProLogis is developing speculative sites at Wellingborough and Kettering.

ProLogis Park Kettering is strategically sited close to both the M1 and A1 and will be inaugurated by a 40,800 m² warehouse currently nearing completion.

The warehouse, due to be operational in May 2006, has been pre-let to kitchen equipment manufacturer BSH Home Appliances, a subsidiary of Bosch-Siemens, and in the words of ProLogis UK Vice-President Simon Jenkins will provide "a state-of-the art building in a prime location for UK distribution".

Steelwork contractor Atlas Ward Structures constructed the steel portal frame under a design and build contract, following on from the success of a similar project at ProLogis Park Wellingborough.

The Kettering project uses 1250 tonnes of structural steelwork and is nearly twice the floor area of the Wellingborough job. The eight-span portal frame measures 236m wide overall, by 20 bays of 7.875m long. Height to the underside of the haunch is 11.5m. Atlas Ward designed the structure using the CSC Fastrak suite.

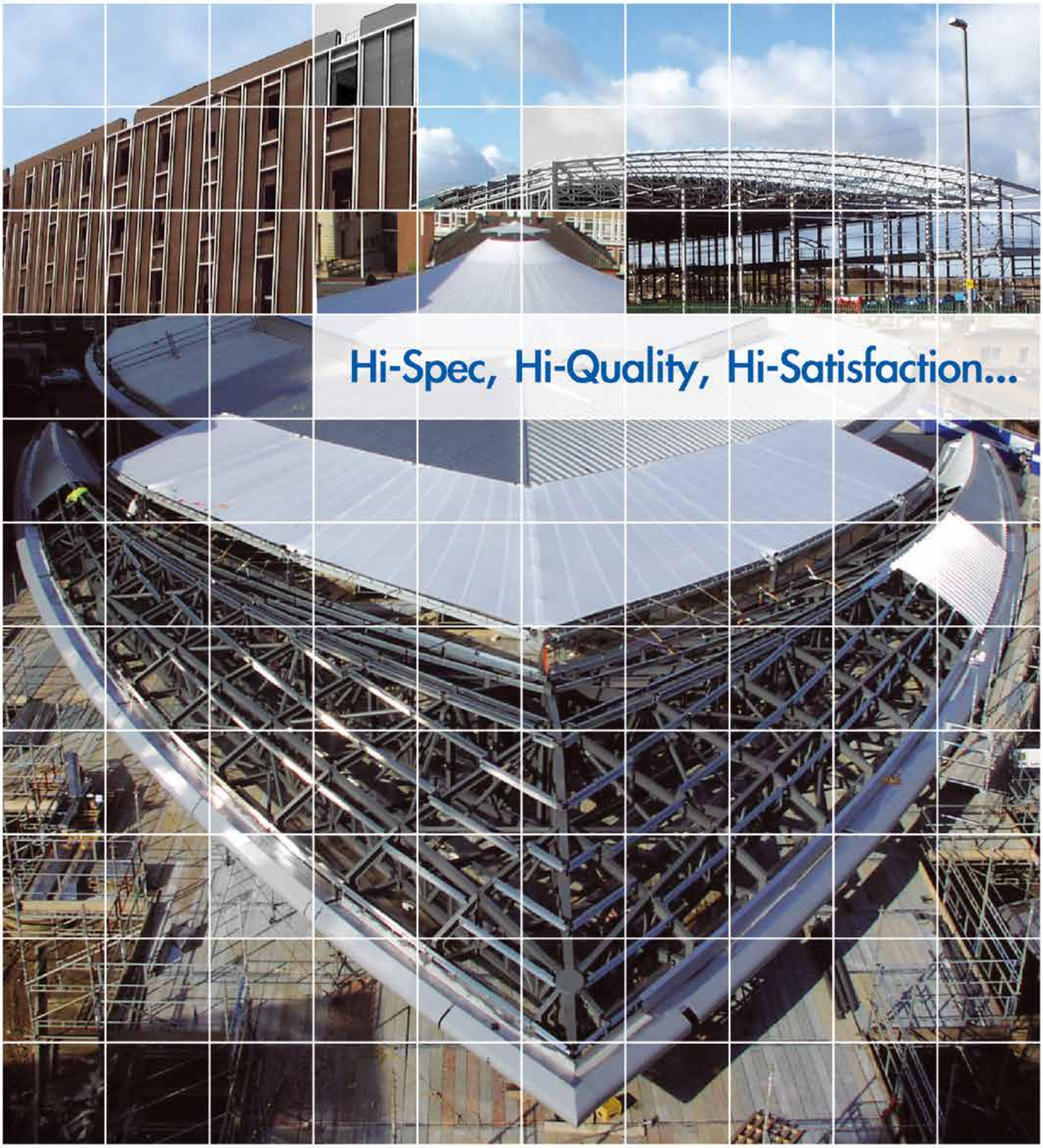
Construction began in May 2005. Steelwork erection was carried out on a fast-track programme between June and early August. "We finished a week ahead of programme," says Atlas Ward Project Manager Peter Church.

The building includes a two-storey administrative office on one side and a part-internal, part-external two-storey hub at the rear, which forms the interface between the warehouse and goods going in and out. There are four level access doors and 29 dock levellers, and parking space for 98 trucks.

Main contractor for the project is Winvic Construction, with architect Stephen George & Partners and structural engineer Capita Symonds.

ProLogis Park Kettering will eventually provide 204,000m² of distribution space on the 49ha site. It is strategically located off junction 7 of the A14 east-west link road, which connects the M1 at Rugby with the A1 at Huntingdon, respectively 32km and 43km away. The developer currently has 11 new buildings on site in the UK, totalling over 400,000m².

Atlas Ward has designed, fabricated and erected over 4,800t of structural steel, representing almost 140,000m² of space, for ProLogis over the last year. It is already working with the same project team on its next ProLogis job, a warehouse of double the size on an adjacent part of the Kettering development.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Race against time in fast-moving medical drama

A new private sector-provided orthopaedic treatment centre for Cheshire and Merseyside was urgently needed. Fortunately, by using steel a demanding schedule was devised and a top quality facility delivered. David Fowler reports

Next May a new orthopaedic treatment centre opens its doors at Halton General Hospital near Runcorn, with the aim of drastically reducing waiting times for surgery. Nothing remarkable about this — except that, under the fastest of fast track programmes the first patients will be admitted only 17 months from the start of design work on the £17M PFI project.

Cheshire & Merseyside Independent Sector Treatment Centre will provide 44 beds and four operating theatres. It is being built as part of a government strategy to provide faster treatment through the private sector, using a series of specialist centres designed to undertake a high volume of particular types of routine operations, free from the seasonal and emergency demands affecting the wider National Health Service (NHS).

The Halton ISTC will help the local NHS Trust meet the target of cutting waiting times for patients requiring orthopaedic surgery to six months by December 2008.

The centre is intended to revert to the National Health Service in five years. "The building was designed to the brief of the client, Interhealth Canada, but it has to meet NHS requirements so that it can be handed to the NHS," says Project Director Mark Carter of Devereux Architects.

Built in the grounds of the existing Halton General Hospital, the centre is arranged on three levels totalling around 6,000m^2. The ground floor houses outpatient and day treatment facilities including examination rooms and physiotherapy clinics, plus radiology and imaging — X-Ray, MRI and CT scanners. In-patient wards are on the first floor, while the third floor accommodates operating theatres and their associated storage areas for equipment, plus administrative offices. A plant room is situated at roof level.

The project was needed so quickly there were initial difficulties in finding a main contractor. Steve Miller, Technical Director of structural engineer WSP Cantor Seinuk, says: "We went to a number of contractors. We narrowed it down to two, both of which pulled out. Then Bovis Lend Lease said they could do it two months more quickly."

The scheme design had to be done in three days to meet a deadline for agreeing funding, and work on site started soon afterwards, in January this year. "As we were doing detailed calculations the contractor was digging holes in the ground," says Mr Miller.

On the choice of materials, he says: "We looked at precast and reinforced concrete but chose a steel frame with metal deck floors because of the fast track nature of the project."

The steel frame is a straightforward beam and column design on a 7.5m grid. "We considered cellular beams for the floors but the services provider preferred a flat soffit to pass underneath rather than going through beam webs," says Mr Miller. "So we used universal column sections as beams to maximise floor-ceiling height." All primary beams were standardised as 305mm UCs of two different weights. 305mm UCs are also used for most of the columns.

Stability is provided by cross-bracing in the stair cores at the corners. A two-bay central courtyard rises the full height of the building, with balconies overlooking it at first floor level.

FACT FILE
Cheshire and Merseyside Independent Sector Treatment Centre
Client:
Interhealth Canada
Main contractor:
Bovis Lend Lease
Architect:
Devereux Architects
Structural engineer:
WSP Cantor Seinuk
Steelwork contractor:
The AA Group Ltd
Steeldeck flooring:
Metaldeck Ltd
***Project value:** £17M*
Steelwork tonnage:
535t

There are no changes in the layout from floor to floor and hence no need for complex transfer structures. "The whole aim of designing for a fast track programme was to simplify and use repetition so the M&E contractors could plough on with their programme," Mr Miller explains.

The composite floors employ Kingspan Multideck profiles 150 to 175mm deep, installed by Metaldeck. The floors are designed using the standard SCI method for checking vibration frequency.

Externally, lightweight terracotta rainscreen tiles are supported on an independent secondary cold-formed frame constructed using the Avon Dry Wall Beam system, with insulation between the frame members. "In the initial design the cladding was to span between columns," says Mr Miller, "but because of the programme the cladding supplier recommended using separate rails from the ground floor and tying them back to the main frame." Internally, cementitious dry lining with lightweight plasterboard is used.

Kevin O'Keeffe, Production Director of steelwork contractor The AA Group (TAAG), says that the fast-track project presented no unusual problems. "We work on a fast-track, just-in-time system on all our projects, with six to eight weeks from receipt of order to site start," he says. "The only issue in this case was that it was the first time we'd used an off-site applied intumescent coating, which reduced the time we had available for fabrication by a week."

Coating supplier Leigh's Paints provided training for TAAG staff on the benefits and practicalities of working with off-site intumescents. Tests were carried out using Leigh's 'fire bay' to check that shot-firing the shear studs for the floor decking to the beams had no adverse effect on the effectiveness of the intumescent coating.

TAAG also liaised closely with WSP over the construction sequence. "We discussed which end of the building we wanted to start from, and divided the building into sections. We then advised the engineer which areas to concentrate on designing first," says Mr O'Keeffe.

TAAG designed the steelwork for speed of erection. Stubs designed to carry the loads from the beams were fitted to the faces of the columns, allowing the beams to be made with a clearance between the column faces so they could be fitted more quickly. Normally the beams would be bolted directly to the columns but for this they have to be a precise fit and need 'shoehorning' into place.

TAAG's own edge protection system was fitted to the beams before they were lifted into place, removing the need to erect scaffolding before work could start on the floors.

Erection of the 535t of steelwork and floor decking began in early May and was completed by July.

Work is so far going well, despite initial reactions: "Everyone thought the speed was totally unrealistic," says Mr Miller. But the project is currently on time and on budget. There is a big incentive to meet the target dates, however, as Mr Miller points out: "If this goes well there's potential for four or five more across the country."

Clockwise from above: The Treatment Centre comprises three storeys plus a plant room; Repetitive floor plans and the design of the beam-column connections aided fast-track construction; Stability is provided by bracing in the stair cores; An atrium rises the full height of the building.

New tests demonstrate superior performance of steel-framed floors

Recent vibration tests on composite floors in steel-framed hospital buildings have confirmed that the real performance of composite floors is superior to that suggested by a floor comparison study that was published by the Concrete Centre. Dr Stephen Hicks, SCI Manager for Building Engineering reports

Over the last eight years, the SCI has been involved in UK and European-sponsored research on floor vibrations. This has resulted in a database of measurements on steel-framed floors being compiled, together with the development of predictive tools that have been calibrated against these measurements. This article presents the results of recent vibration tests on composite floors in steel framed hospital buildings. It was discovered that all of the steel-framed floors out-performed the NHS requirements for operating theatres by a factor of between 2 and 4. These measurements are in stark contrast to results presented by the Concrete Centre in 2004, which were based on simplistic comparisons of concrete and steel floors using only predictive methods.

Vibration tests on composite floors

Attempts have recently been made to compare the response factor performance of different floor systems (*Concrete Quarterly*, Winter 2004)[1]. This study was based on applying predictive techniques to a single simple floor and comparing the theoretical effect of different construction methods on response factor values. The floor construction methods that were considered were RC flat slab, post-tensioned RC flat slab, a conventional steel and concrete composite floor and the Slimdek system. Although this approach facilitates comparisons, it has the following disadvantages:

- The simple floor is not representative of floor layouts commonly used in practice.
- No allowance is made for the position of the walking activity in relation to areas where a particular response factor is required (e.g., operating theatres in hospital buildings only represent a small proportion of the total floor area)
- As the performance of each floor is based only on predictions, the comparisons are strongly affected by accuracy of these predictive techniques and the assumptions used in the calculations.

So that fairer comparisons can be made, the SCI arranged to test a number of composite steel-framed hospital floors recently constructed and designed according to the latest guidelines.

Vibration testing requires specialised equipment and sophisticated data processing. The key items of equipment needed are a means of exciting the floor in a controlled way and accelerometers to measure the floor vibrations. Post-processing makes use of methods based on the Fourier transform, which converts a signal measured as a function of time to one in terms of frequency. Two types of excitation method are commonly used: impulsive and continuous forcing.

Impulsive methods

Impulsive methods such as impact hammers are the most transportable, and are usually adequate for simple structures. The hammer is fitted with a soft tip and a force transducer, so that when it is struck it puts a known amount of energy into the structure over a wide range of frequencies. An alternative form of impulsive excitation is the heel drop test, which consists of a single person raising themselves on the balls of their feet, and suddenly dropping on to their heels (in the past, this simple loading function has been used within some design guides to assess the acceptability of floors). However, a long-standing problem with this approach has been that the input force is not measured, and may vary from test to test. Some researchers have recently remedied this by developing an instrumented heel-drop test, where the heel-drop is executed on top of a slim, purpose-built load cell.

Floor	Project	Bay Size (m)	Overall slab depth (mm)	Beam depth Sec/ Pri (mm)	Fundamental frequency (Hz)	Response Factor measured from walking test
1	Hospital 1 Operating Theatre	11.3 × 7.2	300	625/571 Cellular Beam	6.4	0.25
2	Hospital 2 Operating Theatre	15 × 7.5	175	457×152UB/700 Cellular Beam	7.6	0.49
3	Hospital 3 Operating Theatre	8.1 × 8.1	200	533×210UB/ 533×210UB	8.0	0.21
4	St Richards Hospital, Chichester	5.9 × 5.5	335 + 80 screed	300ASB153/-	14.0	0.29
5	Sunderland Royal Hospital	6.8 × 5.7	337	300ASB185/-	17.0	0.54

Table 1. Response factors used to specify satisfactory magnitudes of building vibration with respect to human response.

Measurement and design of vibration response

The basis of measuring and designing for vibration response was covered in an earlier article (The real performance of modern steel-framed floors, NSC June 2005). For convenience, the main points are repeated here.

Vibration magnitude is normally measured in terms of acceleration. To express the severity of human exposure to vibration, a root-mean-square value is used. The perception of vibration depends on the direction of incidence to the human body, and to account for this most modern standards used the 'basicentric' co-ordinate system in which the z-axis corresponds to the human spine.

Traditionally, the design of floors for occupant-induced vibrations has been based on providing a minimum natural frequency (which depends on the ratio of the floor stiffness to its mass).

However, resonant accelerations can still arise from components of the walking activity, and natural frequency limits do not give any indication of the acceleration response. As a consequence, it is now more common for designers make predictions of the RMS accelerations expected in service.

Guidance for designing steel-framed floors for vibrations is given in SCI publication 076[3], which is supplemented by three SCI Advisory Desk Notes[4]. Specific guidance for uniform floor layouts and grids common in hospital buildings has recently been provided in SCI publication 331[5]. These publications permit designers to make an estimate of the expected response factor by using hand calculations.

Alternatively, as numerical modelling of floors becomes commonplace, finite element analysis techniques are sometimes employed. The SCI has developed a software prediction tool that may be used to estimate the response factor for a floor through a research programme supported by the European Commission[2]. This tool has been calibrated against a database of measurements that have been recorded on real floors over the last eight years.

The evaluation of the exposure of humans to vibrations within buildings is covered by BS 6472: 1992[6]. Limits of satisfactory vibration magnitude are expressed in relation to a 'base curve' and a series of multiplying factors (also known as 'response factors'). The base curve for vibrations in the z-axis direction, together with a range of typical factored curves, is shown in Figure 2. Each line in Figure 2 represents a constant level of human reaction, known as an isoperceptibility line. The area above a line corresponds to an unacceptable human reaction. Maximum response factors currently recommended for the UK are given in Table 2, below.

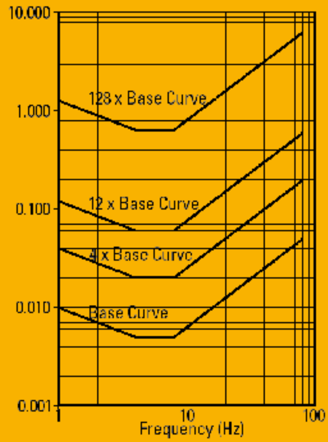

Figure 2, BS6472: 1992 – Building vibration curves for z-axis vibrations

Table 2. Response factors used to specify satisfactory magnitudes of building vibration with respect to human response.

Environment	Time	Response factors	Guidance document
Operating theatre, precision laboratories	Day	1.0	BS 6472: 1992 [6], HTM2045 [7]
	Night	1.0	
Residential, wards within Hospitals	Day	2.0 to 4.0	BS 6472: 1992 HTM2045
	Night	1.4	
Offices, general laboratories	Day	4.0	BS 6472: 1992 HTM2045
	Night	4.0	

Figure 1. Electrodynamic shaker within operating theatre to Floor 4

Continuous forcing methods

Impulsive tests sometimes have difficulty distinguishing between closely spaced natural frequencies. The existence of several very close modes of vibration is quite common in floors, which often have several bays of similar stiffness in each span direction. In such cases, better quality data may be obtained by providing a continuous forcing input to the floor. A novel multi-shaker floor excitation system developed at the University of Sheffield was used on two of the floors presented in this article (Floor 4 and Floor 5 in Table 1). This new and unique modal testing system is based on high-quality frequency response function (FRF) measurement and curve-fitting. It enables adequate distribution of vibration energy, which is the key problem when testing large-scale civil engineering structures; this leads to considerably improved reliability in the measurements. An image of one of the shakers is shown in Figure 1.

As well as determining the damping and frequency, the mode shapes can also be evaluated from testing. This is achieved by moving the excitation source or the accelerometer to a predefined set of grid points on the floor and monitoring the response. On Floor 4, accelerometer readings were taken at 26 points.

Walking tests

Once the modal properties of the floor have been established, the response of the floor can be measured directly from walking tests using a variety of paths and pace frequencies. These measurements can then be compared to published acceptability guidelines to produce in situ 'response factors' (or 'multiplying factors') for the floor.

The aim of walking tests is to ascertain the worst (design) case for the response of floors in service. Through a research programme supported by the European Commission[2] it was found from


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measurements that the average frequency for people engaged in walking activities is 2.0Hz. To take account of variations in service, the walking tests presented in Table 1 were conducted at frequencies of between 1.5–2.5Hz (a range equivalent to three standard deviations about the mean value of 2.0Hz). The pace frequency was controlled by walking in time to a beat generated by a portable computer or a metronome.

The response factor values presented in Table 1 are based on the highest one-second RMS acceleration recorded from walking tests (equivalent to a 'slow' integration time constant according to ISO 2631-1: 1997)[8]

As can be seen from Table 1, all the floors easily satisfied the appropriate performance standards shown in Table 2 for an operating theatre environment, out-performing the HTM 2045[7] requirements by a factor of between 2 and 4. Since acceleration response is inversely proportional to mass, it would indicate that significant reductions to the slab thicknesses could have been made in these cases. For example, for Hospital 4, the 80 mm screed could have been eliminated and the slab to the Slimdek® floor could theoretically have been reduced to 240 mm (though this a thickness that could not be practicably achieved, owing to the depth of the current Asymmetric Slimflor® Beam (ASB) range).

Conclusions

Measurements on five hospital floors using conventional composite construction and Slimdek show that steel-framed floors are easily capable of achieving the strict vibration requirements for operating theatres given in HTM 2045. Furthermore, the implications for Slimdek® floors in hospital buildings is that they do not have to be designed any differently from floors that are commonly used in buildings for the commercial sector.

These measurements also show the dangers of making simplistic comparisons using only predictive methods which, in a previous study[1], inferred that steel-framed floors have an inherent difficulty in achieving hospital performance standards. In that study it was suggested that a Slimdek® floor would need to be significantly deeper than floors in the commercial sector to achieve a response factor of 1.0 (equivalent to a slab depth of 420 mm plus a 50 mm screed). Conversely, in the measurements presented here, a response factor of only 0.29 was achieved on a floor that was 14% thinner.

1 Minson, A: 'A firm footing for good vibrations', Concrete Quarterly, Winter 2004
2 Generalisation of criteria for floor vibrations for industrial, office, residential and public buildings and gymnastic halls, European Coal and Steel Community (ECSC) -Steel Programme, 7210-PR/314
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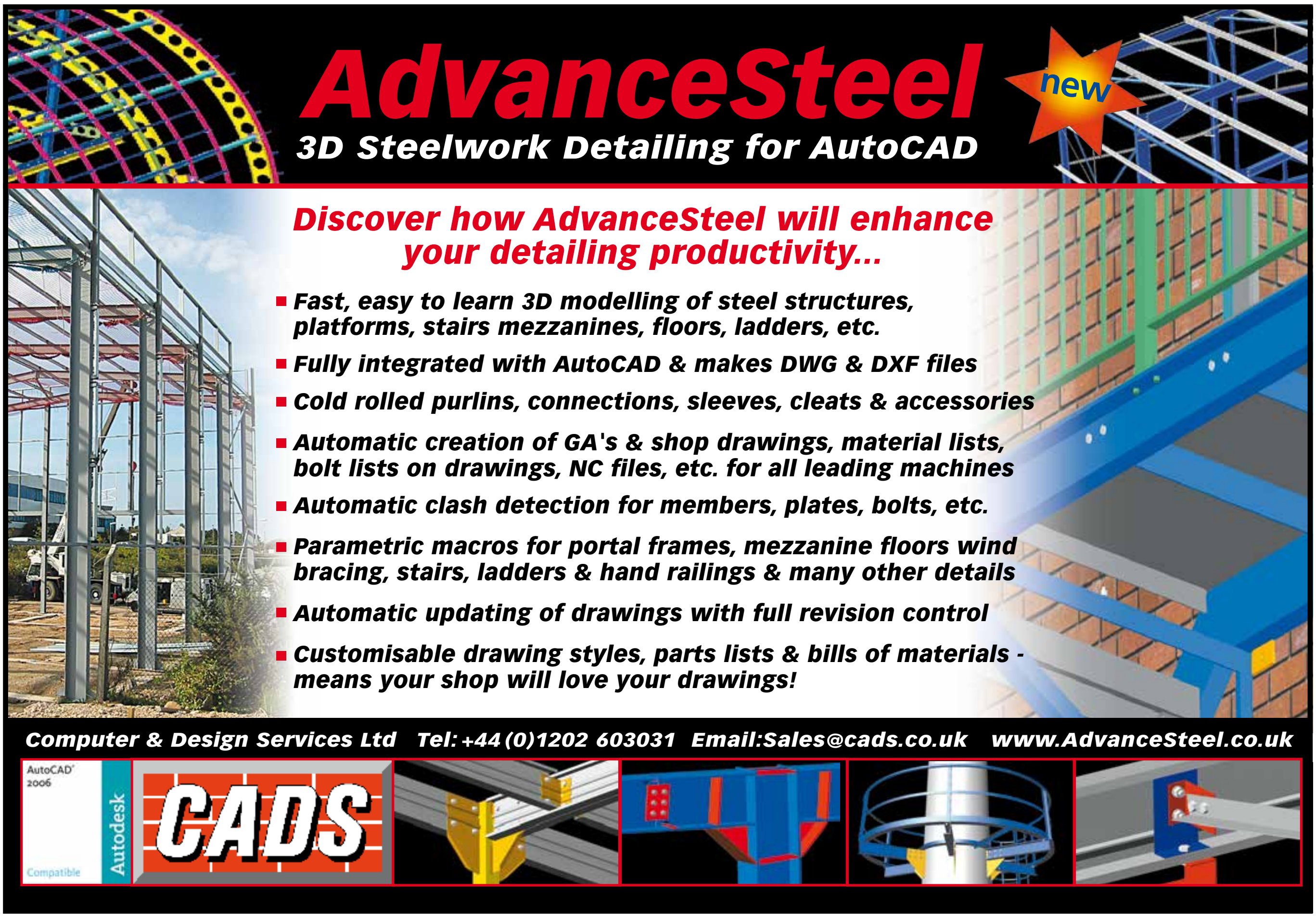
6 BS 6472 Evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz), London, British Standards Institution, 1992
7 Health Technical Memorandum 2045: Acoustics: Design considerations, London, HMSO, 1996
8 ISO 2631-1. Mechanical vibration and shock - Evaluation of human exposure to whole-body vibration: Part 1: General requirements, International Organisation for Standardization, Geneva, 1997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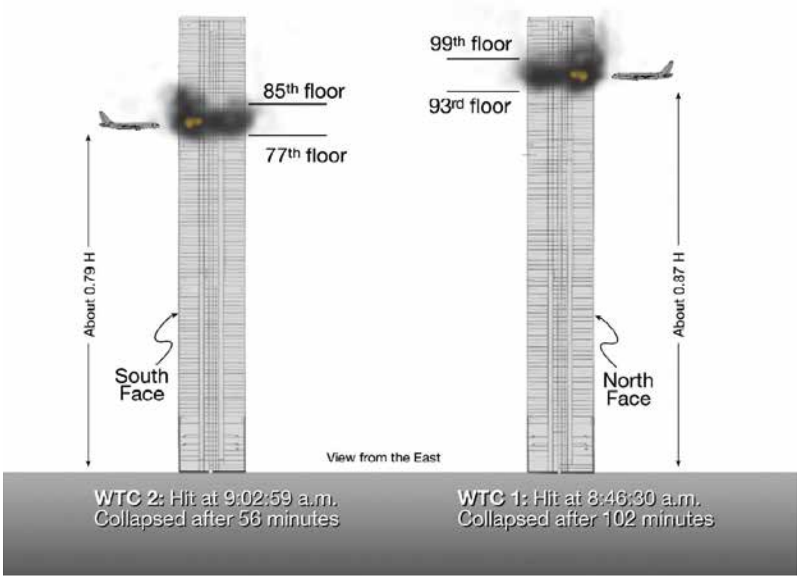
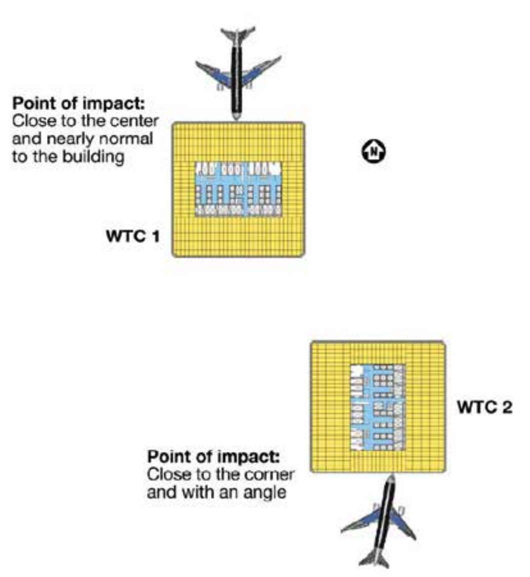
Questions raised over WTC report

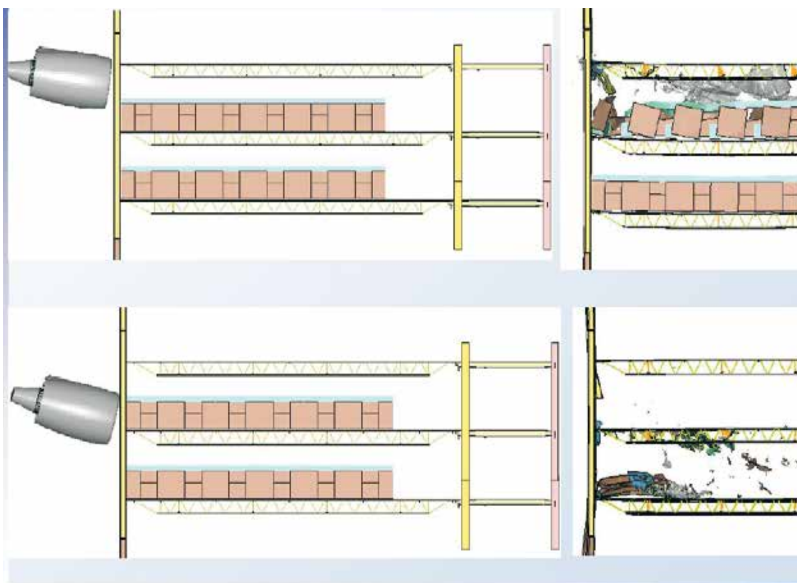
The official conference organised to launch the report into the collapse of the World Trade Center towers took place in September. John Dowling of Corus reports on the issues raised.





Top and centre: NIST's analysis suggests the angle at which the aircraft struck the WTC towers was critical in explaining why one tower collapsed after a much shorter time than the first.

Below: Detailed models of the impact of the aircraft engines were created.

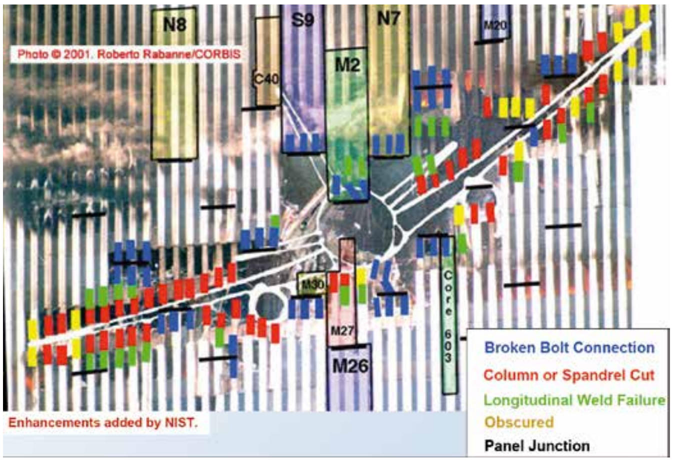


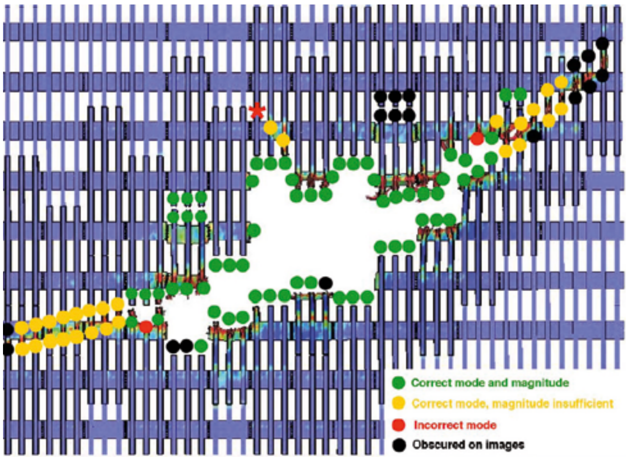
The conference at the headquarters of the National Institute for Standards & Technology (NIST) at Gaithersburg, north of Washington DC, was attended by 170 experts on various aspects of fire design from across the world, 17 of them from the United Kingdom, who were treated to descriptions of probably the most extensive investigation into a structural collapse ever undertaken.

And it was impressive. Thousands of photographs and hundreds of hours of video footage were used to validate immensely complex analyses of the aircraft impact, fuel distribution throughout the affected floors of the buildings, internal and external damage, fire spread and eventual collapse. These analyses, incorporating finite element models with hundreds of thousands of nodes and millions of degrees of freedom, and taking (in some cases) weeks of computing effort to run, are striking. Conference delegates were shown graphic illustrations of the movement of the engines and the fuel through the building and the damage it created. Equally remarkable were detailed models of the progress of the fires across the floors. These helped to explain one of the key questions from the 9th September 2001: why did WTC2 collapse before WTC1 despite being hit afterwards (collapse took place in 56 as compared to 102 minutes).

NIST now claims to have the answer. It would appear that the angle of entry of the aircraft on WTC2 created a greater amount of internal damage and window breakage than occurred on WTC1. Critically, the impact on WTC2 also created a significantly larger pile of debris on the side of the building remote from the contact and this burned with a greater intensity, causing higher temperatures than occurred in the other bulding. The combination of increased temperatures and damage lies at the heart of the differences in performance. The NIST models, which demonstrated this effect, also identified that the collapse of both towers began at the sides of the buildings remote from the initial impact, a conclusion supported by photographic and video evidence.

The conference was divided into seven sessions reflecting the order in which NIST had carried out its investigation. The first and last were occupant egress and emergency response and then building and fire codes and practice. These more or less





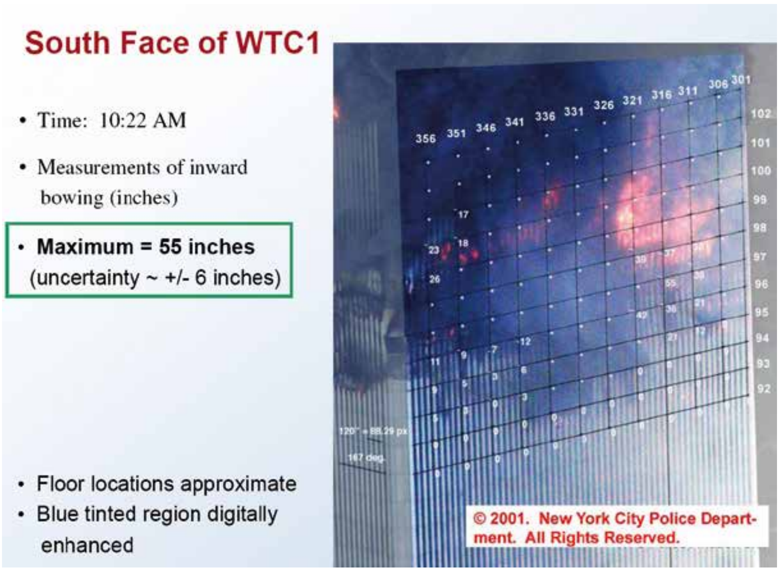
stood alone. The remaining five were: mechanical & metallurgical analysis; baseline structural performance and aircraft impact damage analysis; reconstruction of the thermal environment; analysis of active fire protection systems; and structural fire response and collapse analysis. The progression of these was linear, with each being dependent on the previous analyses and this perhaps is the cause of one of the potential weaknesses of the NIST approach.

This weakness arises from the sheer complexity of the analyses required to determine what happened during an extremely complex event occurring over a relatively short period of time. Put simply, regardless of the confidence NIST has in its analyses, without having been there to see exactly what happened there will always be elements of uncertainty in the results and this will inevitably place confidence intervals on the conclusions. As far as the mechanical and metallurgical analysis was concerned, NIST could be confident that its results were accurate. However, when it came to the baseline structural performance and aircraft impact damage analysis, things were not so clear. In the end, the analysis was able to develop three scenarios for damage: light, baseline and severe. The observed data indicated that the real case was somewhere between the latter two but it could be fixed no more clearly than that. In answer to a question from the floor, NIST admitted that the aircraft impact assessment in particular was very uncertain and that they were looking for global patterns, not accurate specifics.

The reconstruction of the thermal environment also had some problems. The theoretical analysis was backed up by extensive and impressive physical testing but the results agreed with observed data only when a fire load of 4 psf was used and not when this was increased to 5 psf. These are not huge differences and might not alone have been expected to account for the variations in results. In WTC 2, calculations agreed with observations only when it was assumed that much of the fire load was moved to a corner by the impact. This has already been discussed as one of the primary reasons why WTC2 collapsed before WTC1. To put a fire load of 4 psf in perspective, it is approximately 40% of that used during the Cardington steel frame fire tests.

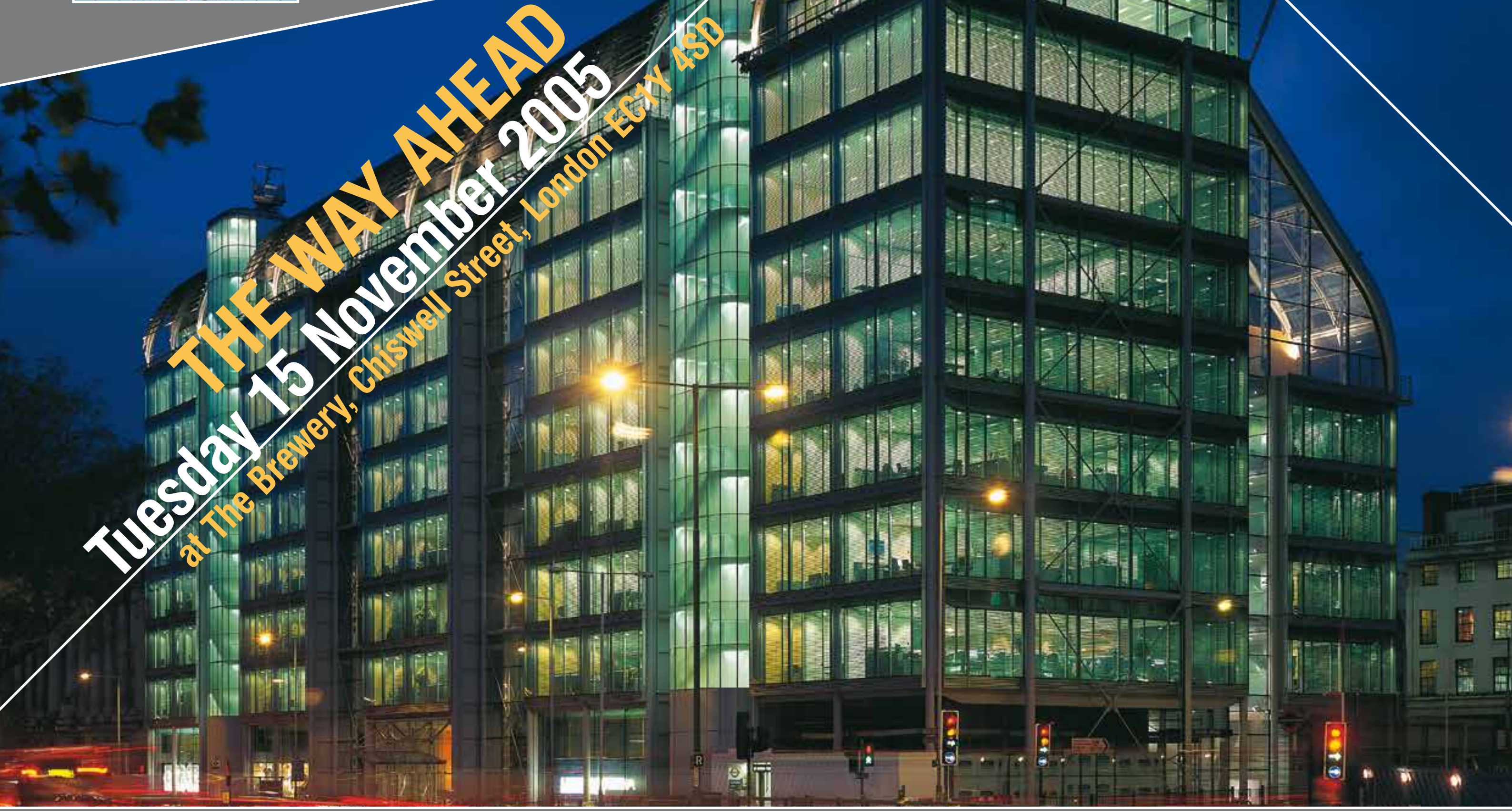
For comparison purposes, the structural model

Above: Photos and video footage were used to validate hghly detailed finite element models in the investigations of the collapse mechanism.
Below: The collapse of both towers began on the side of the building opposite the impact.



BCSA

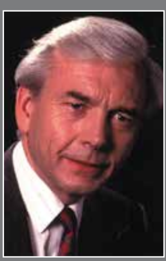
Steel Construction
CONFERENCE & EXHIBITION



This image courtesy of Nick Guttridge

THE WAY AHEAD
Tuesday 15 November 2005
at The Brewery, Chiswell Street, London EC1Y 4SD

The aim of the "Steel Construction – The Way Ahead" Conference and Exhibition is to review the latest developments in the design and construction of steel structures.



The Conference is aimed at clients, designers, main contractors, steelwork contractors and suppliers.

John Humphrys, TV Presenter, will Introduce and Chair a Panel Discussion on "The Future Construction Market".

All delegates will receive a copy of a comprehensive new book "Steel Details", to be published by BCSA at the Conference. This new book will illustrate steelwork detailing as design decisions in context, not solely as calculation methodologies. It will include extensive case study material and reference data.

The Exhibition will open at 0930 hrs and will close at 1715hrs.

Exhibitors will include: steelwork contractors, suppliers of steel, software, purlins, cladding, decking, stud welding, bending, cellular beams, fabrication machinery, corrosion protection.

The Conference will commence at 1030hrs and conclude at 1615hrs.

The Conference fee is £160, plus VAT = £188. The fee includes attendance at the Conference and Exhibition, lunch, documentation and a copy of the new "Steel Details" book.

The event is being held at The Brewery, which is Samuel Whitbread's origional London brewery, built by John Smeaton and James Watt in 1750.

For Booking Forms contact: Gillian Mitchell MBE, Deputy Director General, BCSA 4 Whitehall Court, Westminster, London SW1A 2ES
Direct Tel: 020 7747 8121 **Fax:** 020 7839 4729 **email:** gillian.mitchell@steelconstruction.org **Web:** www.steelconstruction.org

developed for NIST calculated that collapse would have taken place 43 minutes after impact at WTC2.

The NIST analysis identified the critical issue in the collapse of the towers as being the removal of most of the structural fire protection by the debris which hurtled through the buildings and the shock waves which followed the moment of impact. Had the fire protection remained intact, NIST believes that that buildings would have survived. This is not a scenario which finds agreement at Arup Fire which has carried out its own analysis, and believes that the towers were vulnerable had the threat come only from fires on three floors.

There were several other contributors from the UK including Dr. Bill Allen of Leigh's Paints. He made a presentation on work he had carried out which showed the ability of modern intumescent coatings to survive explosions and maintain their functionality when subjected to over-pressures in excess of those at the World Trade Centre.

Other than from Arup Fire, open criticism of the report was generally muted. One exception was a sharp attack on the investigation into occupant response and evacuation which rebuked the emphasis placed on the immediate reaction of the survivors in a survey carried out by NIST; 30 questions were devoted to immediate reactions compared to only three on the building evacuation.

It was clear from the conference that, in taking on the analysis of the collapse of the twin towers, NIST had accepted an enormous task. Aspects of the report are open to criticism and examples of this have been described. Some conclusions are debatable and it is likely that, had NIST looked outside the US for expertise, it might have modified some of its findings. For example, a finding that creep effects in fire were highly significant in the collapse is inconsistent with the results of extensive large scale fire testing in the UK. Nevertheless, the report is a significant body of work and NIST has made no claims that it is definitive. Shortcomings are accepted and these should be understood when reading the report. Many of the conclusions and recommendations are common sense and many emphasise what will undoubtedly become good practice in tall and high risk buildings. For this, at least, NIST is to be commended.

All presentations from the conference have been placed on a website at *http://wtc.nist.gov/WTC_Conf_Sep13-15/presentations905.htm*
Readers who wish to know more about the probable collapse sequence can do so by accessing the presentation 'Probable Collapse Sequence and Key Findings.'

Computer simulations of the impacts can be found at *http://www.nist.gov/public_affairs/releases/wtc_briefing_april0505.htm*

Joint approach lifts health and leisure

Burnley's health and leisure facilities will be greatly improved by the completion of a flagship centre, believed the first in the UK to bring both uses together.

Above: The finished centre will dominate Burnley's skyline
Right: The critical load case for the atrium roof trusses is supporting scaffolding for the adjacent 10-storey block

Rapidly taking shape in the centre of Burnley is a structure that will dominate the Lancashire town's skyline.

The 10-storey tower of St Peter's Centre, which was topped out at the end of September, makes it Burnley's tallest building. It is also thought to be unique in the UK in combining health and leisure centres in a single building complex.

The centre is being built under the Local Improvement Financial Trust which brings together three East Lancashire primary care trusts with private sector partner, local main contractor the Eric Wright Group.

Nationally, LIFT is a Department of Health initiative designed to improve the facilities and premises for primary care services — general practitioners and community services — allowing the services themselves to be expanded.

A number of health centres have already been completed under the seven-year, £65M East Lancashire LIFT programme, but these have been on a smaller scale and were part new-build, part-refurbishment projects. The £28M St Peter's Centre is the programme's flagship project.

Design work on a stand-alone health centre was at an early stage when Burnley Borough Council came on board with the idea of combining it with a new sport and leisure facility to replace the town's existing sports centre.

The health centre will provide a wide range of services including the primary care trust's out-of-hours doctor's service, while the leisure centre will feature two swimming pools, a sports hall, squash courts, a dance studio and the usual range of leisure centre facilities. One of the pools will be 25m long, while the learner pool will have an adjustable floor, allowing its depth to be varied up to a maximum of 3m.

The complex is effectively divided into two buildings by a movement joint running down the side of the four-storey atrium which forms the entrance to the complex. On one side of the atrium lie most of the health facilities in a partly 10-storey and partly seven-storey building. On the other side of the atrium lie four storeys of offices shared between the health and leisure functions. Alongside this is the swimming pool and sports hall.

Steelwork alone accounts for £2.3M of the project value. Structurally, the pool and sports halls are braced frames but in each there is a large transfer truss at one end.

In the swimming pool this supports one side of the adjacent four-storey office block over a span of 21m. The truss in the sports hall supports squash

Far left: The four-storey atrium contains two internal footbridges.
Left: The main tower provides panoramic views of the town. The four storey block and sports hall/swimming pool block are in the foreground.
Below: A 21m span transfer truss supports the four-storey office block adjacent to the pool

courts and spans 18m. Both are fabricated from universal column sections.

The swimming pool steelwork is protected by a special coating specification recommended by Casco's Paints: the sections are galvanised and coated with chlorine-resistant paint, giving them a life to first maintenance of 20 years.

Spectators are catered for by a cantilevered viewing gallery at one end of the pool.

Down the side of the swimming pool building there will be a row of full-height external columns, dividing halfway up to form a 'Y' shape. These are there for effect and have no load-bearing function.

Visitors will gain their first impression of the building as they enter via the four-storey atrium. Another Y-column will stand outside under a glazed canopy; an 18m high 365mm circular hollow section column stands just inside the full-height glazed screen of the atrium's main façade.

At atrium roof level, eight trusses span 11m across the atrium. Though they support the atrium roof, their critical load case occurs during construction, carrying the scaffolding running up the face of the adjacent 10-storey block.

The central section of the atrium trusses, which will be left exposed, is fabricated in circular hollow section; universal column sections are used for the ends, which will be enclosed behind finishes.

Internal footbridges at second and third floor level within the atrium connect offices at the rear of the building with the stair and lift landings.

The main 10-storey block is a conventional framed structure, with a repetitive floor plan to help speed construction. Composite metal deck floors also act compositely with the beams.

The fast-track programme made steel the obvious choice of material. Work on site started in January. The leisure centre is due for completion by the end of the year — after less than 12 months on site. The health centre is due to open by summer 2006.

Steve Mason, Billington Technical Director, says: "We sat in with the structural engineer to value-engineer the design both before and after we won the job, and to make sure the details lent themselves to fast track construction. For example we were able to advise on details such as what column size to specify, so that we could design the splice details to be easy to manufacture and easy to put together on site. We worked very closely to make sure the design met all the client's requirements at an economic price."

The site is cramped and access is restricted, but following surveys of the nearby roads Billlington was able to deliver the large transfer trusses in one piece and erect them in one lift.

Main contractor Eric Wright assisted steelwork erection by using higher strength concrete and reducing curing periods to allow work to proceed faster. Steel erection finished six to eight weeks ahead of programme.

"It was always a tight programme," says Ian Entwisle, an Associate of structural engineer Booth King Partnership. "For a complicated £28M project, progress has been phenomenal." The programmed six months between finishing the leisure and health centres is unlikely to be needed, he predicts: "It will finish well within programme."

And though this may be the first centre to combine both functions it is unlikely to be the last. There is a compelling logic to siting the two together, as David Peat, chief executive of Burnley, Pendle and Rossendale Primary Care Trust points out: "Prevention of illness by keeping fit and healthy, with the right diet and the right amount of exercise, is the way forward, and this building will help provide that opportunity."

FACT FILE
St Peter's Health and Leisure Centre Burnley
Client: *A public private partnership between: Burnley Borough Council; Burnley, Pendle and Rossendale Primary Care Trust; East Lancashire Building Partnership; Eric Wright Group Limited*
Design and construct contractor: *Eric Wright Group*
Architect: *Nightingale Associates*
Structural Engineer: *Booth King Partnership*
Steelwork Contractor: *Billington Structures Ltd*
Contract value: *£28M*
Steelwork tonnage: *1250 tonnes*

A pre-cast concrete car park was formerly on the site.

SCI's new Software SATEL Delivers Simplicity in Explosion Analysis

Viken Chinien introduces SATEL, a new package that incorporates the latest theoretical developments and extends the applicability of traditional design methods for structures subject to blast loads.

The SCI has developed state-of-the-art software SATEL (Structural Analysis Tool for Explosion Loading) for the analysis of single-degree-of-freedom (SDOF) systems subjected to explosion loads. The software is based on pioneering theoretical developments described in the Fire and Blast Information Group (FABIG) Technical Note 7 [1] and provides analysts and designers with the practical means to perform explosion analysis without recourse to complex implicit or explicit non-linear finite element analysis (NLFEA).

SATEL allows designers to account for plasticity, large displacements and strain rate effects in their SDOF analysis of structural members and panels under explosion loading. It can be used in many practical applications where structures can be modelled as SDOF systems, such as blast walls and structural members or panels in buildings, ships and offshore platform decks. It enables designers to quickly assess the structural performance of the system, particularly at the preliminary design stage, leading to a substantial reduction in the costs for such analysis.

The software was developed as part of a Joint Industry Project and incorporates the following features:

- It extends the limit of applicability of the traditional Biggs method [2] to account for unequal support capacities, finite support axial and rotational stiffness and capacity, strain rate effects and improved methods for determining plastic strains.
- It provides a user-friendly interface designed in collaboration with the project partners. This uses familiar interface controls — that is, it looks and feels like standard desktop software using Microsoft Windows controls.
- It is supported by a Theory Manual and a User Guide, which gives background to the calculations and guidance on use of the package.

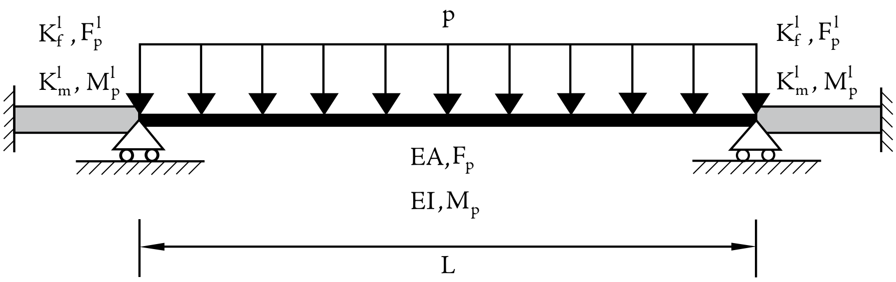


Figure 1, Geometric configuration and boundary conditions

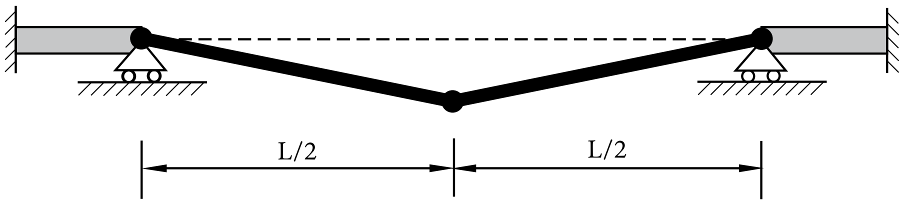


Figure 2, Plastic collapse mechanism

Theory and Assumptions

Single degree of freedom systems are those in which the response of the structural element or system to an explosion is dominated by the first mode of vibration. It is restricted to structural systems which may realistically be simplified to a single mass on a spring.

The most widely applied SDOF model has so far been that of Biggs [2], which suffers from the following shortcomings:

- It does not incorporate the effects of support flexibility, since it assumes either pinned or fixed conditions.
- It does not account for different moment capacities at the two supports.
- It ignores the catenary effect, which has a significant influence on the large displacement member response in the presence of axial restraint at the supports.
- It ignores the influence of material rate-sensitivity
- It ignores the influence of strain-hardening through assuming elastic perfectly plastic material and cross-sectional responses.
- It does not account for the beam-column effect in load-bearing members that sustain significant compressive axial forces.

The approach developed in FABIG Technical Note 7 [1] overcomes the first four shortcomings of the Biggs model.

The problem characteristics and assumptions for the new SDOF model are as follows:

- The member has uniform cross-sectional properties along its length
- The cross-sectional response is elastic perfectly plastic (i.e. no strain hardening)
- The member has two end supports where transverse displacements are restrained (Figure 1).
- Arbitrary elastic perfectly plastic conditions are to be considered for the two end supports for both rotational and axial deformations (Figure 1)
- Strain-rate effect is accounted for
- The loading and mass are uniformly distributed along the member length (Figure 1)
- Both bending and catenary actions are to be considered for the member.

Further assumptions were made to facilitate the formulation of a relatively uncomplicated model which should nevertheless capture the essential problem characteristics:

- Static member failure is associated with a three-hinge plastic mechanism for the case of non-zero rotational support stiffnesses (Figure 2).
- The internal plastic hinge is at mid-span.
- The interaction between the plastic bending moment and axial force is linear.
- Material rate sensitivity is governed by the Cowper-Symonds model.

SATEL Development

The software functional requirements for SATEL were developed in conjunction with the partners on this Joint Industry Project (JIP), which included the Health and Safety Executive, defence technology specialist Qinetiq and blast wall manufacturer Mech-Tool Ltd.

The software was designed in a simple and easy-to-use format that guides the user through the various steps by providing ‘hover help’ messages relating to each input parameter. Graphical aids are included throughout to help the user in verifying the input data with warning and error messages, as appropriate, if the validation ranges for the parameters are exceeded.

Development followed the same rationale as other engineering software with input blocks for:

- Section properties (Figure 3)
  - Database of UK sections (UB/UC/RHS/SHS/CHS)
  - Corrugated profiles
  - User defined section properties

- Overall geometry
  - Overall length
  - Mass per unit length (default value if database section is chosen)

- Material properties (Figure 4)
  - Carbon Steel
  - Stainless Steel

  Users can also define their own material properties. Default values for the material properties are provided for materials in the SATEL database which includes most carbon steel and stainless steel grades. The material properties include Young’s modulus, yield strength, damping ratio, ultimate strain and ductility ratio. If strain rate effects are included, default values are also provided for the strain rate and the Cowper-Symonds constants for the materials in the SATEL database.

- Boundary conditions (Figure 5)
  - Fixed supports
  - Pinned supports
  - Finite axial & rotational stiffness
  - Any variation of the above

- Strain rate
  - Reference displacement rate – default value provided
  - Support rate parameters – default values provided

- Loading

  Three options are provided for the time-history variation of the load, namely:
  - Type I profile – triangular blast profile
  - Type II profile – triangular blast profile with rebound
  - Type III profile – general blast profile

- Analysis
  - SATEL analysis screen allows the user to define the duration of the analysis and change the default time-step of 2.0 x 10-5 seconds

- Output

  SATEL provides the user with three different output screens, namely:
  - Summary: provides a summary of the input and output data.
  - Results (Figure 6): allows user to plot resistance-displacement curve and time-history curves for all output parameters (left & right support reactions, midspan displacement, velocity and acceleration, mid-span plastic strain, left & right support plastic strain, ductility ratio)
  - Calculations Log: provides user with detailed list of all input, intermediate and output parameters used in the calculations including elastic natural frequency, dynamic load factors and rebound dynamic load factors.

The user can export any of the time-history data to text files for further manipulation of data.

A user guide [3] and a theory manual [4] are available online for SATEL.

Availability

SATEL is available under licence from The Steel Construction Institute. For further details and information concerning the software, please contact Dr Viken Chinien (e-mail: v.chinien@steel-sci.com) at the SCI.

Acknowledgements

The development of SATEL was sponsored by the Health & Safety Executive, QinetiQ and Mech-Tool. Their support and help in the project is gratefully acknowledged.

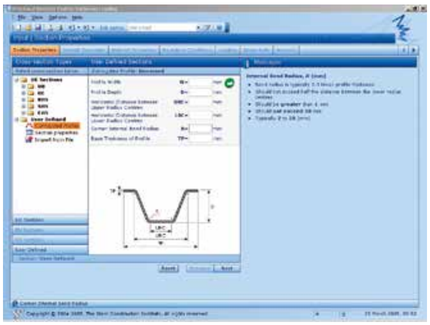


Figure 1 – Section properties screen

Figure 2 – Material properties screen

Figure 3 – Boundary conditions page

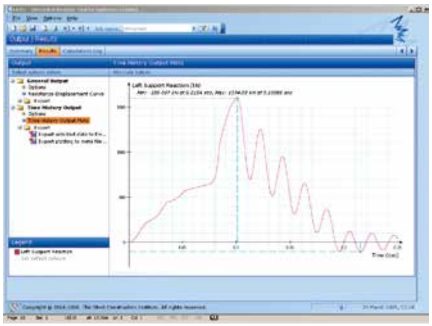


Figure 4, Output screen – Results page: Time History Output Plots

References

1 Fire and Blast Information Group (FABIG), ‘Simplified Methods for Analysis of Response to Dynamic Loading’, Technical Note 7, The Steel Construction Institute, 2002.
2 Biggs, J.M., ‘Introduction to Structural Dynamics’, McGraw-Hill, 1964.
3 SCI RP1061, ‘SATEL User Guide’, The Steel Construction Institute, 2005
4 SCI RP1060, ‘SATEL Theory Manual’, The Steel Construction Institute, 2005.

BUILDING WITH STEEL

Developments at Gatwick Airport

Although Gatwick had been granted an ærodrome licence in 1930 the Airport only began operating in 1936 after completion of work including the construction of a Terminal Building and the building of Gatwick railway station. The first stage of post-war development commenced in 1955 and today (1965) it is second only to Heathrow in the south of the British Isles.

Since then, air traffic at Gatwick has reflected the changing pattern of international commercial aviation. By 1964 the number of passengers had risen to more than three times that of 1959, and it has been estimated that by 1970 the figure will have reached nearly 2½ million per annum. This emphasises the foresight of those responsible for planning the airport.

To meet this forecast increase in air traffic, planning of Stage II Development commenced in 1961 and by 1963 a new north Passenger Pier and additional apron areas had been completed

Left: Gatwick Airport, 1965.

at a cost of approximately £700,000 and the runway was extended another 1,200 ft.

Since then work was been completed to provide additional movement areas and facilities to deal with the expected increase in the number of passengers using the airport. This work cost £2½ million and was finished during the summer of this year. It included enlargement of the Terminal Building to more than double its original size, the construction of a new Passenger Pier, extension of the Operations Block and the building of a new staff canteen. The work was carefully phased to cause minimum inconvenience to passengers and to avoid any delay of flight services: for these reasons much of it was done during the winter months when passenger traffic was lowest.

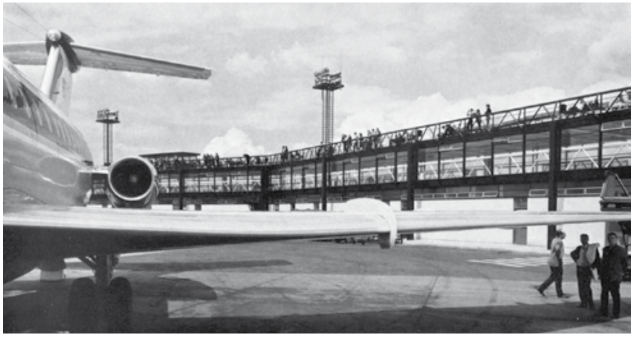
Steelwork plays an important part in the Stage II development. For instance the main structural members of the 1,000 ft. long south Passenger Pier are Universal beams forming welded portal frames spaced at 40 ft centres. The longitudinal trusses on both the roof and first floor level are of welded design consisting of steel tube top booms and mild steel structural sections for all other members.

In the case of the 130 ft. x 350 ft. Terminal Building extension the galvanised steel roof deck over the concourse area is supported on trusses 6 ft. deep spanning 100 ft. at 20 ft. centres and constructed from standard mild steel sections. Housed in the depth of the trusses are the concourse lighting, ventilation trunking and access gangways for maintenance purposes. The trusses also support the suspended ceiling.

Future developments may include the provision of a second runway, the construction of an office block above the terminal building and extensions to passenger and baggage handling facilities, car parks etc.

Co-ordinating Consulting Engineers – Sir Frederick Snow & Partners. Architects – Yorke, Rosenberg, Mardall.

The Stage II development at Gatwick includes a new South Passenger Pier (below). The attractive looking handrail (bottom) is composed of steel tube which forms part of the top booms of the longitudinal trusses.



AD 293
Web panel Zones in Vierendeel Girders (Part 1)

Recently our advisory desk has received a number of questions about Vierendeel girders and particularly about the application of clause 6.1.9 in BS 5950-1: 2000 to joint design. A typical Vierendeel joint between two I-section members is illustrated in Figure 1. The majority of the questions have related to the distinction between F_v and F_{vp} as described in clause 6.1.9 in regard to this type of joint. Clause 6.1.9 defines F_{vp} but leaves the shear force, F_v, which the web panel zone must resist, to be determined by the design engineer. This AD provides advice on the distinction between these two values and AD294 will provide advice on the design of the web panel zone. As a result of the end moments in the vertical members, the magnitude of the shear force in the web panel zone (F_v) in the chord member for this type of joint might be several times that of the shear force in the chord outside the web panel zone.

Background

A Vierendeel girder or truss is an open web girder consisting of top and bottom chords with vertical internal and end members joined by moment resisting connections. A typical girder is illustrated in Figure 2. The members of a Vierendeel girder are therefore subject to bending (Vierendeel moments), shear and axial load effects.

Although Vierendeel girders are more expensive to produce than conventional trusses with diagonal members, they provide useful solutions in certain scenarios; for example, for storey-deep transfer structures when the removal of the diagonal members from a conventional truss is desirable for access reasons.

Structural Analysis

Vierendeel girders are usually designed elastically and the model used in the structural analysis of these girders normally consists of a series of line elements connected to moment resisting (rigid) nodes. Plastic design is used occasionally.

Typical results for an elastic structural analysis of a Vierendeel girder are shown in Figure 3. The members of the girder are then checked for the interaction of moment, shear and axial load using a design code, typically section 4.8 in BS 5950-1: 2000

Vierendeel girders lend themselves to analysis by statically determinate sub-frames due to the presence of points of inflection in the middle region of the members. Typical results for the structural analysis of a simple sub-frame are shown in Figure 4.

Analysis of Joints

Designers should be aware that structural analysis based on line elements alone will not in itself be sufficient to provide the design value of the shear force in the web panel zone for the typical joint shown in Figure 1. The depths of the internal members and chords must be taken into account to find the value of the shear force in the web panel zone.

The calculation of the shear force in many web panel zones may be carried out by a few simple calculations but the subject is best introduced by an understanding of the interaction of member sizes and sub-frames. Figure 4 shows the forces and moments on a sub-frame of the upper part of the left side of the Vierendeel girder shown in Figure 2 and subject to vertical loads.

If the moments and axial force in the vertical

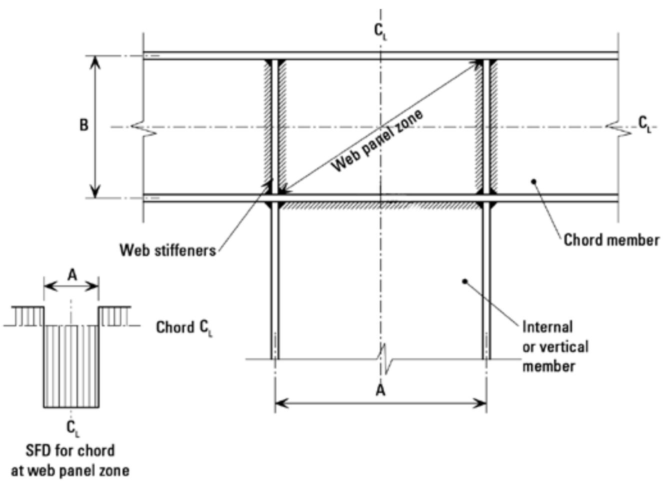


Figure 1. Typical Vierendeel Joint using Open Sections

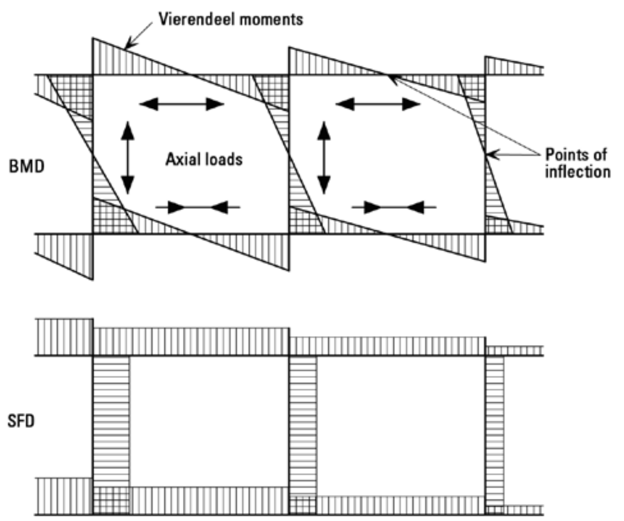


Figure 3. Elastic Bending Moment and Shear Force Diagrams for a Vierendeel Girder

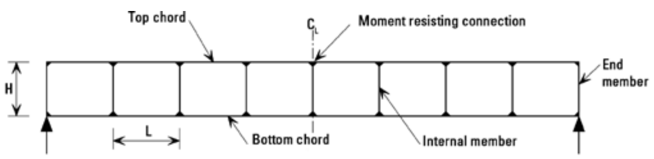


Figure 2. Components of a Vierendeel Girder

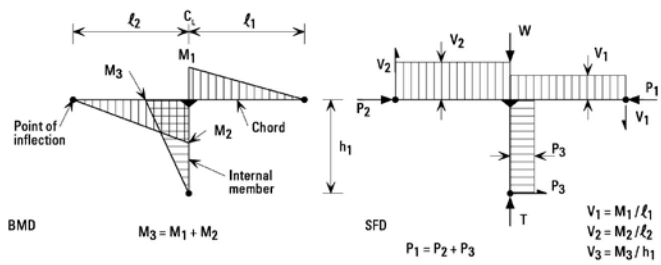


Figure 4. Bending Moment and Shear Force Diagrams for simple Vierendeel sub-frame

member are assumed to be carried by the flanges alone then the bending moment and shear force diagrams for the chord are simple linear diagrams as shown in Figure 5.

In terms of clause 6.1.9 of BS 5950-1: 2000, F_{vp} is the panel zone shear force resulting from the introduction of the global end moment from the vertical member, where the flanges are a distance A apart, and is given by:

$$F_{vp} = M_3/A = (M_1 + M_2)/A$$

This model is the same as used in BS 5950-1: 2000 clause 6.1.9 in which:

$$F_{vp} = M_{tra} /(D_d - T_b) = M_3/A$$

However, the actual shear force in the web panel zone is the value F_v as shown in Figure 5. The value of Fv depends on the shear in the chord, the load on top of the chord and the compressive force in the vertical member and is given by:

$$F_v = F_{vp} - V_1 - W/2 + T/2$$

This is usually taken as:

$F_v = F_{vp} - V_{min}$ where V_{min} is the lesser of V_1 and V_2

As the bending moment diagram is linear in this analysis and shear is the rate of change of moment (or in other words, the slope of the bending moment diagram), the shear force in the web panel zone may alternatively be determined from:

$$F_v = (M_{1f} + M_{2f}) / A$$

Where the values M_{1f} and M_{2f} are determined from the global forces in the sub frame and the width of the vertical member. If the full cross–section of the vertical member is required to resist the moment, a more complex analysis needs to be performed, which will give curved bending moment and shear force diagrams in the connection zone.

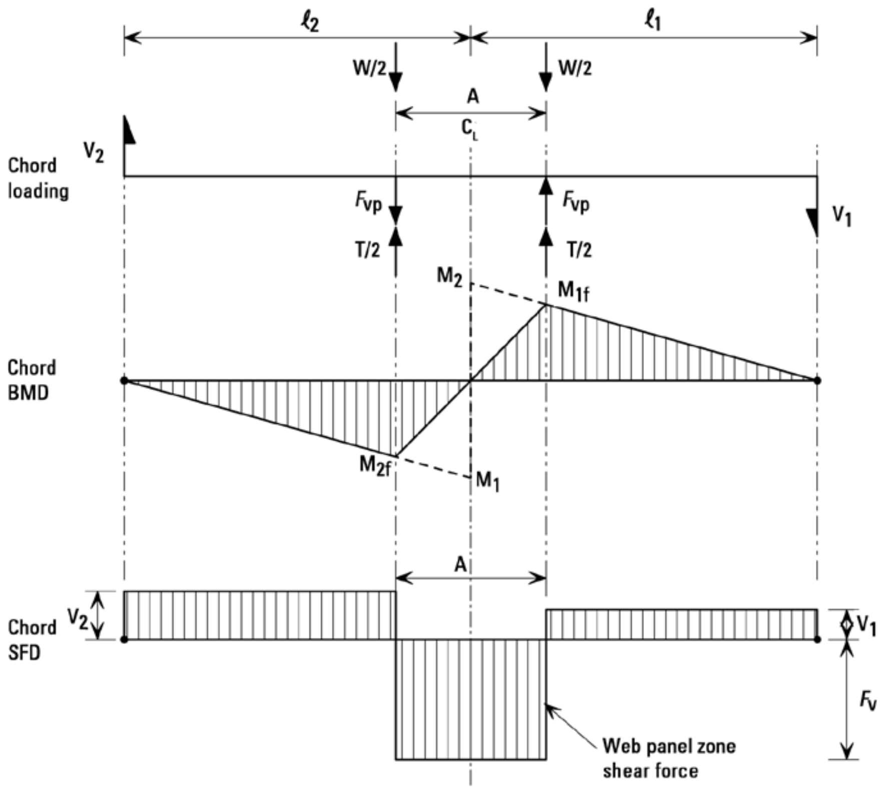


Figure 5. Modified BMD and SFD for Chord of Vierendeel Girder

AD 294 will conclude this series of notes on Vierendeel Girders in NSC Vol 14 No 1 January 2006.

Contact: Thomas Cosgrove
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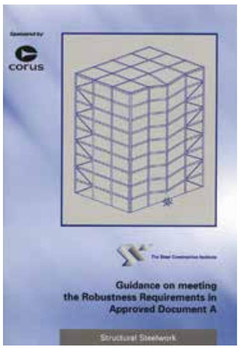

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Details of BCSA Membership and services are available from: Gillian Mitchell MBE, Deputy Director General, British Constructural Steelwork Association Ltd, 4 Whitehall Court, Westminster, London SW1A 2ES. **Tel** 020 7839 8566 **Fax** 020 7976 1634

KEY

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- **D** High rise buildings
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- **J** Major tubular steelwork
- **K** Towers
- **L** Architectural metalwork
- **M** Frames for machinery, supports for conveyors, ladders and catwalks
- **N** Grandstands and stadia
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Cowdenbeath KY4 8LP
Tel 01383 518610 **Fax** 01383 513099

ROBERTS ENGINEERING
16D Bergen Way, Sutton Fields Ind. Est.,
Hull HU7 0YQ
Tel 01482 838240 **Fax** 01482 830697

J. ROBERTSON & CO LTD (L M S 9)
Mill Lane, Walton-on-Naze CO14 8PE
Tel 01255 672855 **Fax** 01255 850487

ROBINSON CONSTRUCTION (C D E F H 1 Q1)
Wincanton Close, Ascot Drive Industrial Estate,
Derby DE24 8NJ
Tel 01332 574711 **Fax** 01332 861401

ROWECORD ENGINEERING LTD (A B 0 Q1)
Neptune Works, Uskway, Newport,
South Wales NP20 2SS
Tel 01633 250511 **Fax** 01633 253219

ROWEN STRUCTURES LTD (A 1)
Fulwood Road (South),
Sutton-in-Ashfield, Notts NG17 2JW
Tel 01623 558558 **Fax** 01623 440404

S H STRUCTURERS LTD
Moor Lane Trading Estate, Sherburn-in-Elmet, North Yorkshire LS25 6ES
Tel 01977 681931 **Fax** 01977 681930

SELWYN CONSTRUCTION ENGINEERING LTD
Tarron Road, Tarron Industrial Estate, Moreton, Wirral CH46 4TU
Tel 0151 678 0236 **Fax** 0151 678 8959

SEVERFIELD-REEVE STRUCTURES LTD (A 0* Q2)
Dalton Airfield Industrial Estate, Dalton, Thirsk, North Yorkshire YO7 3JN
Tel 01845 577896 **Fax** 01845 577411

SHIPLEY FABRICATIONS LTD
Maddocks Park, Ancaster, Grantham,
Lincs NG32 3PL
Tel 01400 231115 **Fax** 01400 231220

SNASHALL STEEL FABRICATIONS CO LTD
Pulham Business Park, Pulham,
nr Dorchester, Dorset DT2 7DX
Tel 01300 345588 **Fax** 01300 345533

SOUTH DURHAM STRUCTURES LTD
South Church Enterprise Pk, Dovecot Hill, Bishop Auckland, Co. Durham DL14 6XR
Tel 01388 777350 **Fax** 01388 775225

TAYLOR & RUSSELL LTD
Stonebridge Mill, Longridge PR3 3AQ
Tel 01772 782295 **Fax** 01772 785341

THE AA GROUP LTD
Priorswood Place, East Pimbo,
Skelmersdale, Lancs WN8 9QB
Tel 01695 50123 **Fax** 01695 50133

TRADITIONAL STRUCTURES LTD (E F H J K M N 6 Q1)
Findel Works, Landywood Lane, Cheslyn Hay, Walsall, West Midlands WS6 7AJ
Tel 01922 414172 **Fax** 01922 410211

TUBECON
Badminton Road, Yate, Bristol BS17 5HX
Tel 01454 314201 **Fax** 01454 273029

WARLEY CONSTRUCTION COMPANY LTD
Swinborne Road, Burnt Mills Industrial Estate,
Basildon, Essex SS13 1LD
Tel 01268 726060 **Fax** 01268 725285

WALTER WATSON LTD (Q4)
Greenfield Works, Ballylough Rd, Castlewellan,
Co Down BT31 9JQ
Tel 028 4377 8711 **Fax** 028 4377 2050

WATSON STEEL STRUCTURES LTD (A B 0* Q1) PO Box 9, Lostock Lane, Bolton BL6 4TB
Tel 01204 699999 **Fax** 01204 694543

WESTBURY PARK ENGINEERING LTD
Brook Lane, Westbury, Wilts BA13 4ES
Tel 01373 825500 **Fax** 01373 825511

WESTOK LTD (Q2)
Horbury Junction Ind Est, Horbury Junction, Wakefield WF4 5ER
Tel 01924 264121 **Fax** 01924 280030

JOHN WICKS & SON LTD
Unit 1, Crabbers Cross, Rattery,
South Brent, Devon TQ10 9JZ
Tel 01364 72907 **Fax** 01364 73054

WIG ENGINEERING LTD
Barnfield, Akeman Street,
Chesterton, Oxon OX26 1TE
Tel 01869 320515 **Fax** 01869 320513

H. YOUNG STRUCTURES LTD (C E F H J N 6)
Ayton Road, Wymondham, Norfolk NR18 0RD
Tel 01953 601881 **Fax** 01953 607842

ASSOCIATE MEMBERS

BUILDING COMPONENTS

ALBION SECTIONS LTD (Q4)
Albion Rd, West Bromwich,
West Midlands B70 8BD
Tel 0121 553 1877 **Fax** 0121 553 5507

AYRSHIRE METAL PRODUCTS (DAVENTRY) LTD (Q1)
Royal Oak Way, Daventry NN11 5NR
Tel 01327 300990 **Fax** 01327 300885

BARNSHAW PLATE BENDING CENTRE LTD
Corporation Rd, Audenshaw,
Manchester M34 5LR
Tel 0161 320 9696 **Fax** 0161 335 0918

CELLBEAM LTD
Unit 516, Thorp Arch Estate, Wetherby,
West Yorkshire LS23 7DB
Tel 01937 840614 **Fax** 01937 840608

CORUS PANELS & PROFILES (Q1)
Severn Drive, Tewkesbury Business Park, Tewksbury,
Glos GL20 8TX
Tel 01684 856600 **Fax** 01684 856601

FABSEC LTD
Brooklands Court, Tunstall Road, Leeds LS11 5HL
Tel 0113 385 7830 **Fax** 0113 272 7587

HI–SPAN LTD
Ayton Rd, Wymondham NR18 0RD
Tel 01953 603081 **Fax** 01953 607842

KINGSPAN METL-CON LTD (Q4)
Sherburn, Malton, N. Yorkshire YO17 8PQ
Tel 01944 712000 **Fax** 01944 710555

RICHARD LEES STEEL DECKING LTD
Moor Farm Rd West, The Airfield, Ashbourne,
Derbyshire DE6 1HD
Tel 01335 300999 **Fax** 01335 300888

MSW STRUCTURAL FLOOR SYSTEMS
Acton Grove, Long Eaton, Nottingham NG10 1FY
Tel 0115 946 2316 **Fax** 0115 946 2278

METSEC PLC (Q2)
Broadwell Rd, Oldbury, West Mids B69 4HE
Tel 0121 601 6000 **Fax** 0121 601 6181

STRUCTURAL METAL DECKS LTD
Mallard Hse, Christchurch Rd, Ringwood BH24 3AA
Tel 01425 471088 **Fax** 01425 471408

STRUCTURAL SECTIONS LTD (Q1)
PO Box 92, Downing St,
Smethwick, Warley B66 2PA
Tel 0121 555 1342 **Fax** 0121 555 1341

STUDWELDERS LTD
Millennium Hse, Severn Link Distribution Centre, Newhouse Farm Ind Est, Chepstow, Monmouthshire NP16 6UN
Tel 01291 626048 **Fax** 01291 629979

COMPUTER SOFTWARE

ACECAD SOFTWARE LTD
Truro House, Stephenson's Way,
Wyvern Business Park, Derby DE21 6LY
Tel 01332 545800 **Fax** 01332 545801

COMPUTER SERVICES CONSULTANTS (UK) LTD
Yeadon House, New St, Pudsey, Leeds, LS28 8AQ
Tel 0113 239 3000 **Fax** 0113 236 0546

PSYCLE INTERACTIVE LTD
The Stable House, Whitewell, Whitchurch, Shropshire SY13 3AQ
Tel 01948 780120 **Fax** 08701 640156

RAM INTERNATIONAL (EUROPE) LTD
4 Woodside Place, Glasgow G3 7QF
Tel 0141 353 5168 **Fax** 0141 353 5112

TEKLA (UK) LTD
Tekla House, Cliffe Park Way,
Morley, Leeds LS27 0RY
Tel 0113 307 1200 **Fax** 0113 307 1201

DESIGN SERVICES

ARRO-CAD LTD
Bretby Business Park, Ashby Road,
Bretby, Burton-on-Trent DE15 0YZ
Tel 01283 558206 **Fax** 01283 558207

DEVELOPMENT DESIGN DETAILING SERVICES LTD
171 Bradshawgate, Bolton, Lancs BL2 1BH
Tel 01204 396606 **Fax** 01204 396634

ODDA DESIGN LTD
The White House, Clifton Marine Parade, Imperial Business Park, Gravesend, Kent DA11 0DY
Tel 01474 352849 **Fax** 01474 359116

STEEL PRODUCERS

CORUS CONSTRUCTION & INDUSTRIAL
Frodingham House, PO Box 1,
Brigg Road, Scunthorpe DN16 1BP
Tel 01724 404040 **Fax** 01724 404229

CORUS TUBES
PO Box 101, Weldon Rd, Corby,
Northants NN17 5UA
Tel 01536 402121

MANUFACTURING EQUIPMENT

FICEP (UK) LTD
10 The Courtyards, Victoria Park, Victoria Road,
Leeds LS14 2LB
Tel 0113 265 3921 **Fax** 0113 265 3913

KALTENBACH LTD
6-8 Brunel Road, Bedford MK41 9TJ
Tel 01234 213201 **Fax** 01234 351226

PEDDINGHAUS CORPORATION UK LTD
Unit 6, Queensway Link,
Stafford Park 17, Telford TF3 3DN
Tel 01952 200377 **Fax** 01952 292877

VOORTMAN UK LTD
Unit 8, Mercian Park, Felspar Rd,
Amington Rd, Tamworth B77 4DP
Tel 01827 63300 **Fax** 01827 65565

PROTECTIVE SYSTEMS

AMERON INTERNATIONAL
Blackwell Road, Huthwaite,
Sutton in Ashfield, Notts NG17 2RL
Tel 01623 511000 **Fax** 01623 559616

FORWARD PROTECTIVE COATINGS LTD
Vernon St., Shirebrook, Mansfield,
Notts NG20 8SS
Tel 01623 748323 **Fax** 01623 748730

INTERNATIONAL PAINT LTD
Protective Coatings, Stoneygate Lane, Felling,
Gateshead NE10 0JY
Tel 0191 469 6111 **Fax** 0191 495 0676

LEIGH'S PAINTS
Tower Works, Kestor Street, Bolton BL2 2AL
Tel 01204 521771 **Fax** 01204 382115

SITE COAT SERVICES LTD
Unit 11, Old Wharf Road, Grantham,
Lincolnshire NG31 7AA
Tel 01476 577473 **Fax** 01476 577642

JACK TIGHE LTD
Kirk Sandall Ind. Est., Kirk Sandall,
Doncaster DN3 1QR
Tel 01302 880360 **Fax** 01302 880370

WEDGE GROUP GALVANIZING
c/o Worksop Galvanizing Claylands Avenue,Worksop,
Notts S81 7BQ
Tel 01909 486384 **Fax** 01909 482540

SAFETY SYSTEMS

EASI-EDGE
Ollerton Rd, Tuxford, Newark, Notts NG22 0PQ
Tel 01777 870901 **Fax** 01777 870524

STEEL STOCKHOLDERS

ADVANCED STEEL SERVICES LTD
South Ribble Industrial Estate, Capitol Way,
Preston, Lancs PR5 4AJ
Tel 01772 259822 **Fax** 01772 259561

ASD METAL SERVICES – EDINBURGH
24 South Gyle Crescent,
Edinburgh EH12 9EB
Tel 0131 459 3200 **Fax** 0131 459 3266

ASD METAL SERVICES – BODMIN
Unit 13, Cooksland Ind. Est.,
Bodmin, Cornwall PL31 2PZ
Tel 01208 77066 **Fax** 01208 77416

ASD METAL SERVICES – LONDON
Thames Wharf, Dock Road, London E16 1AF
Tel 020 7476 9444 **Fax** 020 7476 0239

ASD METAL SERVICES – CARLISLE
Unit C, Earls Way, Kingsmoor Park Central, Kingstown,
Cumbria CA6 4SE
Tel 01228 674766 **Fax** 01228 674197

ASD METAL SERVICES – HULL
Gibson Lane, Melton, North Ferriby,
East Riding of Yorkshire HU14 3HX
Tel 01482 633360 **Fax** 01482 633370

ASD METAL SERVICES – GRIMSBY
Estate Road No. 5, South Humberside Industrial Estate, Grimsby DN31 2TX
Tel 01472 353851 **Fax** 01472 240028

ASD METAL SERVICES – BIDDULPH
PO Box 2, Tunstall Road, Biddulph,
Stoke-on-Trent, Staffs ST8 6JZ
Tel 01782 515152 **Fax** 01782 522240

ASD METAL SERVICES – DURHAM
Drum Road, Drum Industrial Estate,
Chester-le-Street, Co. Durham DH2 1ST
Tel 0191 492 2322 **Fax** 0191 410 0126

ASD METAL SERVICES – CARDIFF
East Moors Road, Cardiff CF1 5SP
Tel 029 2046 0622 **Fax** 029 2049 0105

ASD METAL SERVICES – STALBRIDGE
Station Rd, Stalbridge, Dorset DT10 2RW
Tel 01963 362646 **Fax** 01963 363260

ASD METAL SERVICES – NORFOLK
Hamlin Way, Kings Lynn, Norfolk PE30 4LQ
Tel 01553 761431 **Fax** 01553 692394

ASD METAL SERVICES – EXETER
Sidmouth Road, Clyst St Mary, Exeter EX5 1AD
Tel 01395 233366 **Fax** 01395 233367

ASD METAL SERVICES – DAVENTRY
Royal Oak Ind. Est., Daventry,
Northants NN11 5QQ
Tel 01327 876021 **Fax** 01327 87612

ASD METAL SERVICES – TIVIDALE
Tipton Road, Tividale, Oldbury,
West Midlands B69 3HU
Tel 0121 520 1231 **Fax** 0121 520 5664

AUSTIN TRUMANNS STEEL LTD
Moss Lane, Walkden, Manchester M28 5NH
Tel 0161 790 4821 **Fax** 0161 799 0411

BARRETT STEEL SERVICES LTD
Barrett House, Cutler Heights Lane, Dudley Hill,
Bradford BD4 9HU
Tel 01274 682281 **Fax** 01274 651205

BROWN MCFARLANE LTD
Ladywell Works, New Century Street, Hanley, Stoke-on-Trent ST1 5QH
Tel 01782 289909 **Fax** 01782 289804

CORUS SERVICE CENTRE
Farnigham Road Station, South Darenth,
nr Dartford DA4 9LD
Tel 01322 227272 **Fax** 01322 864893

CORUS SERVICE CENTRE
Badminton Rd Trading Est., Yate,
Bristol BS37 5JU
Tel 01454 315314 **Fax** 01454 325181

CORUS SERVICE CENTRE
Spittlegate Industrial Estate, Grantham,
Lincolnshire NG31 7UP
Tel 01476 565522 **Fax** 01476 562459

CORUS SERVICE CENTRE
Blackamore Road, Walker Industrial Estate,
Guide, Blackburn BB1 2LJ
Tel 01254 55161 **Fax** 01254 670836

CORUS SERVICE CENTRE
South Street, Glasgow G14 0BX
Tel 0141 959 1212 **Fax** 0141 959 0111

CORUS SERVICE CENTRE
Moira Rd, Lisburn, Co. Antrim BT28 2SN
Tel 01846 660747 **Fax** 01846 660748

CORUS SERVICE CENTRE
Wakefield Rd, Stourton, Leeds LS10 1AY
Tel 0113 276 0660 **Fax** 0113 272 4418

CORUS SERVICE CENTRE
The Steelpark, Steelpark Way, Wednesfield,
Wolverhampton WV11 3BR
Tel 01902 484000 **Fax** 01902 484041

DUDLEY IRON & STEEL CO LTD
Unit 8, Autobase Industrial Estate, Tipton Road,
Tividale, West Midlands B69 3HU
Tel 0121 601 5000 **Fax** 0121 601 5001

NATIONAL TUBE STOCKHOLDERS LTD
Dalton Industrial Estate, Dalton, Thirsk,
North Yorkshire YO7 3HE
Tel 01845 577440 **Fax** 01845 577165

NEWTON STEEL STOCK LTD
Landshire Lane, Gibbs Marsh Trading Estate,
Henstridge, Somerset BA8 0TN
Tel 01963 365028 **Fax** 01963 365034

RAINHAM STEEL CO LTD
Kathryn House, Manor Way,
Rainham, Essex RM13 8RE
Tel 01708 522311 **Fax** 01708 559024

STEELSTOCK (BURTON ON TRENT) LTD
Ryder Close, Cadley Hill Road, Swadlincote,
Derbyshire DE11 9EU
Tel 01283 226161 **Fax** 01283 550406

STRUTHERS & CARTER LTD
Erimus Works, Valletta Street,
Hedon Road, Hull HU9 5NU
Tel 01482 795171 **Fax** 01482 786186

STRUCTURAL FASTENERS

THOMAS WILLIAM LENCH LTD
P O Box 31, Excelsior Works, Carnegie Road, Rowley Regis, West Mids B65 8BZ
Tel 0121 559 1530 **Fax** 0121 559 3920

CORPORATE MEMBERS

BALFOUR BEATTY POWER NETWORKS LTD
Tel 01332 661491

GRIFFITHS & ARMOUR
Tel 0151 236 5656

HIGHWAYS AGENCY
Tel 08457 504030

ROGER POPE ASSOCIATES
Tel 01752 263636

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
Adstone Construction Ltd	01905 794561														In process of audit
Atlas Ward Structures Ltd	01944 710421	●	●	●	●	●	●	●	●	●	●			●	Up to £6,000,000*
B D Structures Ltd	01942 817770			●	●	●	●								Up to £1,400,000*
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 682281				●	●	●							●	Up to £6,000,000
Billington Structures Ltd	01226 340666	●	●	●	●	●	●	●	●	●	●	●		●	Up to £6,000,000
Bison Structures Ltd	01666 502792			●	●	●	●							●	Up to £2,000,000
Border Steelwork Structures Ltd	01228 548744		●		●	●	●	●				●			Up to £800,000
Bourne Steel Ltd	01202 746666	●	●	●	●	●	●	●	●	●	●	●		●	Up to £6,000,000
Briton Fabricators Ltd	0115 963 2901		●			●	●	●	●	●	●			●	Up to £800,000
Brooksby Engineering	01707 872655														in process of audit
CTS Ltd	01484 606416						●	●							Up to £800,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000*
Compass Engineering Ltd	01226 298388		●		●	●	●		●						Up to £2,000,000
Leonard Cooper Ltd	0113 270 5441		●			●	●		●		●			●	Up to £800,000
Curtis Engineering Ltd	01373 462126					●									Up to £400,000
Frank H Dale Ltd	01568 612212			●	●	●								●	Up to £4,000,000
Dew Construction Ltd (Fabrication Division)	0161 624 5631				●	●	●		●		●			●	Up to £800,000
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 £2,000,000
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 £2,000,000
Mifflin Construction Ltd	01568 613311			●	●	●	●				●				Up to £2,000,000
Harold Newsome Ltd	0113 257 0156				●	●	●								Up to £1,400,000
Normanby Wefco Ltd	01724 875555		●						●		●			●	Up to £800,000
Oswestry Industrial Buildings Ltd	01691 661596				●	●	●		●		●				Up to £400,000
Quantrill Steel Ltd	01953 881853				●	●	●	●		●	●			●	Up to £40,000
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 £800,000
Varley Construction Company Ltd	01268 726020														in process of audit
Watson Steel Structures Ltd	01204 699999	●	●	●	●	●	●	●	●	●	●	●		●	Above £6,000,000*
Webcox Engineering Ltd	01249 813225				●	●	●				●				Up to £400,000
H Young Structures Ltd	01953 601881		●		●	●	●	●				●			Up to £800,000

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.

RQSC
The Register of Qualified Steelwork Contractors Scheme

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*
CTS Ltd	01484 606416	●	●		●	●			Up to £800,000
Cleveland Bridge UK Ltd	01325 381188	●	●	●	●	●	●		Above £6,000,000*
Dew Construction (Fabrication Division)	0161 624 5631	●	●	●			●		Up to £800,000
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*
Mandall Engineering Ltd	0114 243 0001	●	●	●	●	●	●		Up to £800,000*
Meldan Fabrications Ltd	01652 632075	●	●	●	●	●	●		Up to £2,000,000
'N' Class Fabrication Ltd	01733 558989	●	●	●		●	●		Up to £1,400,000
Normanby Wefco Ltd	01724 875555	●	●	●			●		Up to £800,000
Nusteel Structures Ltd	01303 268112	●	●	●	●				Up to £2,000,000*
C Richardson & Co (Middlesbrough) Ltd	01946 727119								in process of audit
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 (¹) 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

The Steel Construction Institute

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, The Steel Construction Institute, Silwood Park, Ascot, Berks.
Telephone: +44 (0)1344 623345 Fax: +44 (0)1344 622944
Email: pat.ripley@steel-sci.com Website: www.steel-sci.com

The Steel Construction Institute Institute would like to welcome the following new Corporate Members:

UK
Barretts of Aspley Ltd*
Hills of Shoeburyness Ltd*
Martin Healer Development Services Ltd
Wakefield MDC Building Control

* BCSA Members

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