Winners and commendations

AWARDS SPECIAL

Structural Awards 2021

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Contents

Structural Awards 2021

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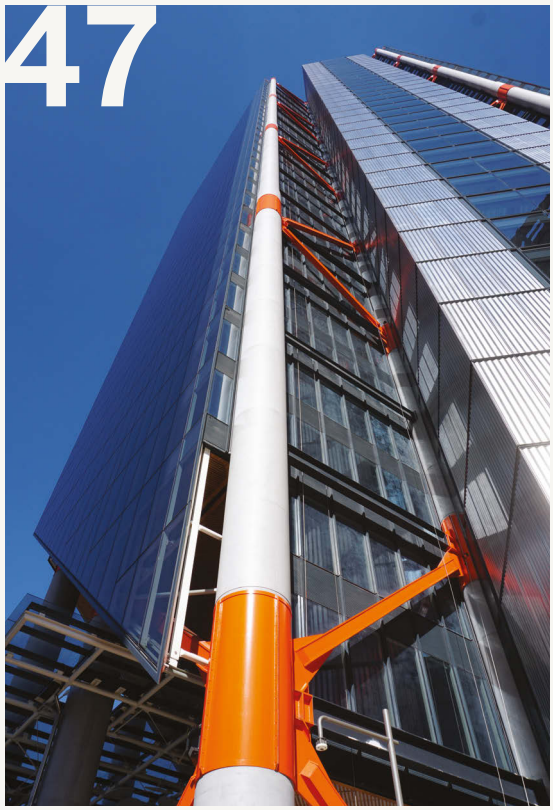

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July 2022

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If you have a concrete project you would like to present, go to **istructe.org/concrete-conference-2022** to download and submit a submission form by 5 January 2022.

Judging panel

Chairman

Prof. Tim Ibell

Tim was President of the Institution of Structural Engineers in 2015, and is a Fellow of the Royal Academy of Engineering. He has a passion for celebrating creativity within our profession, and for using this creativity to inspire students. Tim has been Professor of Structural Engineering at the University of Bath since 2003, including a year's interlude as the Sir Kirby Laing Professor of Civil Engineering at the University of Cambridge in 2017/18.

Roma Agrawal

Roma is a structural engineer and author. From footbridges and sculptures, to train stations and skyscrapers – including The Shard – she has left an indelible mark on London's landscape. She is a tireless promoter of engineering and technical careers to young people, particularly under-represented groups such as women. She has advised policy-makers and governments on science education and has given talks to thousands around the world at universities, schools and organisations, including two for TEDx.

Will Arnold

Will is Head of Climate Action at the Institution of Structural Engineers. He leads the Institution's response to the climate emergency, bringing this action into all aspects of our work, including the publication of best-practice emergency guidance. Prior to his current role, he was a practising structural engineer at Arup for over 10 years, where he was responsible for key aspects of ambitious architectural projects across the world, from the UK to Taiwan and Rwanda.

Dr Michael Cook

Mike is a consultant to Buro Happold, having been a partner of the practice since 1994 and Chairman from 2011 to 2017. He is well known in the industry for his significant contribution to designing innovative buildings and enhancing the reputation of the profession. Mike is a former Vice-President of the Institution and is now Chair of its Climate Emergency Task Group. He was awarded the Institution's Gold Medal in 2020.

Kayin Dawoodi

Kayin is co-lead of a specialist-generalist concept design department at Tyréns in Sweden, developing industry expectations of the structural profession through engineering creativity, education and close collaboration. Before moving to Sweden, he worked at Arup for almost 10 years. He has a background in architectural and structural design of unusual design-led projects across five continents as well as connections at leading universities. He is the current IStructE Representative in Sweden, co-founded the Bridges to Prosperity UK Charitable Trust and is a past winner of the Young Structural Engineering Professional Award.

Tanya de Hoog

Tanya is a founding director of Thornton Tomasetti's London office. Her professional experience spans Europe, the Middle East, Southeast Asia and Australia, where she has worked on a diverse range of projects that focus on engineering creativity and innovation with an intent to foster good design. Celebrating the contribution structural engineering can bring to society, as well as the promoting the importance of continued education and application of sound engineering principles and their relevance to emerging technologies, are of significant importance to Tanya.

Prof. Jiemin Ding

Professor Ding is the Chief Engineer of Tongji Architectural Design (Group) Co., Ltd. Throughout his career he has demonstrated dedication to excellence in structural engineering design. Professor Ding specialises in steel structures, super-high-rise buildings and long-span complex structural systems. He has completed the structural design for more than 10 high-rise buildings above 250m and more than 80 sports buildings. Professor Ding is a Council member of the Institution of Structural Engineers and was awarded the Institution's Gold Medal in 2018.

Paul Fast

Since establishing his own structural engineering consultancy in 1985, Paul has worked on iconic buildings in North America, Europe, Asia and the Middle East. With offices in Frankfurt, New York, Seattle and Vancouver, his firm has become a leader in the design of hybrid structures, which include the Grandview Heights Aquatic Centre, winner of the 2016 Supreme Award for Structural Engineering Excellence, the 18-storey TallWood House at the University of British Columbia, and the 2010 Richmond Olympic Oval. Paul was awarded the Institution's Gold Medal in 2021.

Ian Firth

Ian is a world-leading expert in bridge design and construction. During his career he has been involved with world-famous bridge projects like the strengthening of the Severn Bridge, Erskine Bridge and West Gate Bridge, and the concept design of Stonecutters' Bridge in Hong Kong, as well as many smaller pedestrian bridges such as the new Inner Harbour Bridge in Copenhagen. He is also a leading advocate of bridge-building charity Bridges to Prosperity and a Past President of The Institution of Structural Engineers.

Susan Giahi-Broadbent

Susan has been a Senior Technical Director with Jacobs since 2016. She is a Fellow of the Institution of Structural Engineers and CIHT and an active member of both institutions, involving councils, committees and panels. Susan has accumulated three decades of technical expertise and leadership roles on a variety of high-profile infrastructure and building projects across the UK, Asia and Africa. The majority of her work over recent years has involved transportation schemes, with a focus on highway and rail bridges.

Tristram Hope

Tristram is a chartered structural engineer and Fellow of the Institution of Structural Engineers, with 35 years of experience in multidisciplinary building engineering design and management, having worked with several of the UK's leading practices, including BDP, Buro Happold and Arup. He is founder and Director of independent construction consultancy Thisolutions Ltd, where he works with a wide variety of clients, principally in investigative and advisory roles. Tristram chairs the Industrial Advisory Board for the Department of Civil and Structural Engineering at the University of Sheffield.

Martin Knight

Martin is one of the leading UK architects specialising in the design of bridges and transport infrastructure, and is a Fellow of the RIBA and ICE and an Honorary Fellow of the IStructE. He founded international bridge designers Knight Architects in 2006 and his practice has completed more than 40 bridges in the UK and internationally, including the award-winning Merchant Square Bridge in London, the iconic Lower Hatea River Crossing in New Zealand, and the 270m-long Ulm Kienlesbergbrücke in Germany.

JUDGING CRITERIA

The judges considered the structural engineering characteristics of the project, the extent to which it merited consideration against the category description, and the following overarching criteria:

Sustainability: innovation in material choice, positive impact on society, with reference to the 17 UN Sustainable Development Goals and circular economy principles, quantification of the embodied carbon footprint of the structure (not the whole project) using any named counting scheme, with commentary on how this was minimised.

Creativity and innovation: examples of originality and the application of new and improved technologies and processes in the structural design, particularly where these have led to greater efficiency and economy in the solution.

Elegance and good detailing: engineering structures that demonstrate technical and/or visual elegance, including in the attention to detail, or that contribute to the elegance of the overall design solution.

Value: economic viability and value for money in the structural solution, as well as non-financial indicators of value.

Ease of constructability: characteristics that place the structural engineering solution well beyond the ordinary, including demonstrable examples of how the structural design enabled the project to meet or exceed the client's expectations.

Toby Maclean

Toby is a structural engineer and established Allt environmental structural engineers in 2020, a firm concentrating on addressing the urgent need to decarbonise the built environment with a particular emphasis on carbon embodied in structures. Toby's career so far has been one based on providing practical yet technically sophisticated and holistic solutions to diverse projects in the built environment and concentrating on design from first principles.

Michelle McDowell

Michelle is a Principal and chair of Civil and Structural engineering at BDP, with over 35 years' experience of design and delivery of many challenging, innovative and award-winning projects. In 2010, Michelle was awarded an MBE for services to the construction industry. She is a fellow of the Royal Academy of Engineering and in 2011 was named Veuve Clicquot Business Woman of the Year. In 2012 she was named the ACE's Engineering Ambassador of the Year and in 2020 was given a Lifetime Achievement Award by Women in Construction and Engineering.

Don McQuillan

Don McQuillan is the 2020/21 President of the Institution of Structural Engineers. He is a director of RPS, a global energy resources and environmental consultancy. He specialises in project managing multidisciplinary projects and in structural and forensic engineering. He was first elected to Council in 1989 and has since been involved at HQ, particularly with the development of *The Structural Engineer*, serving on the Editorial Advisory Group until recently. He has authored many technical papers, some award-winning. Don is also an RAE Visiting Professor at Queen's University Belfast.

Dr Andrew Minson

Andrew is Director of Concrete and Sustainable Construction at the Global Cement and Concrete Association. He is currently chair of the Design Practice, Risk and Structural Safety Committee of the Institution of Structural Engineers and a member of its Engineering Leadership Group. He had 10 years with Arup in building engineering where he worked in multidisciplinary teams on international projects before 14 years leading The Concrete Centre in the UK.

Angeliki Palla

Angeliki Palla is a Structural Engineer at O'Connor Sutton Cronin. Originally from Greece, she studied Civil Engineering at the National Technical University of Athens, before completing postgraduate studies in General Structural Engineering at Imperial College, London. She began at OCSC in 2017 and has played an integral part in residential and commercial projects. Angeliki is an active member of the Institution, former Chair of our Young Members Panel and a STEM Ambassador.

Sam Price

Sam founded Price & Myers with Robert Myers in 1978. He has structured many award-winning new buildings, with a particular interest in theatres and concert halls. He has advised on a number of cathedrals, and is a member of the Cathedral Architects Association. He has lectured at Cambridge, Glasgow, Trieste, Bergen, Hong Kong, and Vancouver. He was for 12 years a member of the Architectural Panel of the National Trust.

Roger Ridsdill Smith

Roger is the Head of the Structural Engineering team at Foster + Partners. He is a Fellow of the Institution of Structural Engineers and a licensed Professional Engineer and Structural Engineer in the USA. He was awarded the Royal Academy of Engineering Silver Medal in 2010, and the IABSE Milne Medal in 2017.

Nick Russell

Nick is a Director at Perega, an 80-strong organisation of consulting engineers specialising in civil and structural engineering, glass engineering and building surveying. His extensive experience spans many sectors, including commercial, retail, industrial, education, residential and major losses. Nick has a passion for conceptual design and in making structures as effective as possible. He is a Past President of the Institution of Structural Engineers and a Fellow of the Institution of Civil Engineers and the American Society of Civil Engineers.

Kristina Scheibler-Frood

Kristina is a chartered civil and structural engineer at AECOM working in the London structures team. Over the last eight years she has been involved in the design and construction stages of major projects, specialising in retained facades, listed buildings and deep basements. Kristina is also committed to engaging with students of all ages and the wider community to promote the engineering industry. In recognition of her work, Kristina was awarded the IStructE's Young Structural Engineering Professional Award in 2019.

Elizabeth Side

Elizabeth is a Principal Engineer at Jubb Consulting based in Cardiff and has experience in multiple sectors across the industry, including health, education and residential projects. She successfully co-founded her regional IStructE Young Members Committee and has been an active member of the national Young Members Panel for several years. In 2014, along with a colleague, she won the IStructE Young Structural Engineers International Design Competition. She's an advocate for local STEM events, and is enthusiastic about encouraging students to consider engineering as a career.

Prof. Su Taylor

Su is a Professor of Structural Engineering and Dean of Research for the Faculty of Engineering and Physical Science, at Queen's University Belfast. She is passionate about inspiring structural design creativity in the next generation of structural engineers. Su has close links with the local engineering profession through successful Knowledge Transfer Partnerships (KTPs), and one of her KTPs was awarded the UK Overall Best KTP out of 1000 eligible Partnerships. Su was elected as Vice-President of the International Society for Structural Health Monitoring of Intelligent Infrastructure in 2016.

Peter Terrell

Peter is Chairman of the Board of the Institution of Structural Engineers. He is founder and President of Terrell Group Consulting Engineers. After early years with Ove Arup, Peter set up as sole practitioner in 1982 in Paris, building a practice that is today recognised as one of the leading structural engineering consultancies in France, with over 100 employees. He has been at the forefront of many successful projects, including the Doha Tower (CTBUH Best Tall Building Worldwide 2012) and the DR Byen Concert Hall in Copenhagen.

NEW CATEGORIES

Award for Zero-Carbon Ambition & Award for Minimal Structural Intervention

Given the equal importance placed on sustainability and structural safety in the Institution, it is crucial that the Structural Awards recognise, reflect and reward endeavours by colleagues to aim for net-zero carbon in their projects. One of the best ways to achieve this is by 'doing nothing'.

We have a further award specifically for minimal intervention, where although the overall project cost might not be high in terms of money or carbon, this is only possible through the extraordinary skill of the structural engineer who has developed an alternative minimalist approach to achieve the brief.

Tim Ibell, Chairman

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Award for Construction Innovation

Awarded for projects demonstrating structural engineering excellence and innovation in the design of temporary works and construction processes.

Winner: Apple Marina Bay Sands (Singapore)

PROJECT TEAM

- **Structural designer:** Eckersley O'Callaghan & Foster + Partners
- **Client:** Apple
- **Principal contractor & structural engineer construction documentation:** Gartner
- **Architect:** Foster + Partners
- **MEP engineer:** FCP & Foster + Partners
- **Glass specialist fabricator:** Sedak

IN BRIEF…

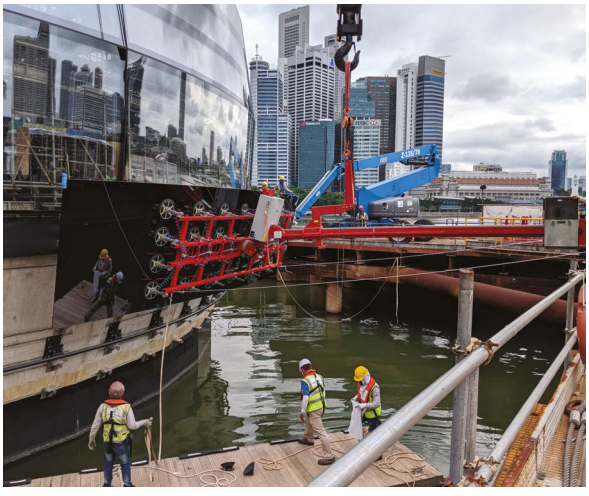
- Apple Marina Bay Sands in Singapore is the largest structure in the world to use glass as the primary bracing system. As a consequence, it has a very slender steel frame, the simplicity of which belies its engineering complexity.
- Its design is the culmination of nearly 20 years of Eckersley O'Callaghan's research, development and practical experience of working with structural glass.
- Every aspect of the design of this incredible project was considered and meticulously detailed.
- At each stage, the engineers worked closely to push the boundaries of engineering design; from the technique used to bend the glass and the bespoke scripting written to analyse the structure, to the connection design and prefabrication for construction.

JUDGES' COMMENTS

This is the largest structure in the world to use glass as the primary bracing system. The 17m high and 30m diameter dome is constructed from 114 conically shaped, tempered and insulated glass panels, 10 steel mullions and 11 concentric steel structural transforms around its perimeter. The simplicity of the very slender steel frame belies its engineering complexity. A solar control coating was used alongside a graded frit on the surface of the glass to minimise solar gain inside the dome. Internal fins are provided to control acoustics and additional insulation to meet environmental standards. The design is the culmination of nearly 20 years of research, development and practical experience of working with structural glass.

Every aspect of the design was considered and meticulously detailed. At each stage, the engineers have worked closely to push the boundaries; from the technique used to bend the glass to the bespoke scripting written to analyse the structure. From the outset, the engineers considered the method and sequence of on-site assembly and in parallel identified the connection detailing and prefabrication for construction of this unique structure.

↗Individual glass panels brace the slender steel-framed structure of Apple Marina Bay Sands



↘Complex installation of lower band of glass panel

Commendation:
King's Scholars Pond Sewer Rehabilitation (London, UK)
Structural designer:
Transport for London

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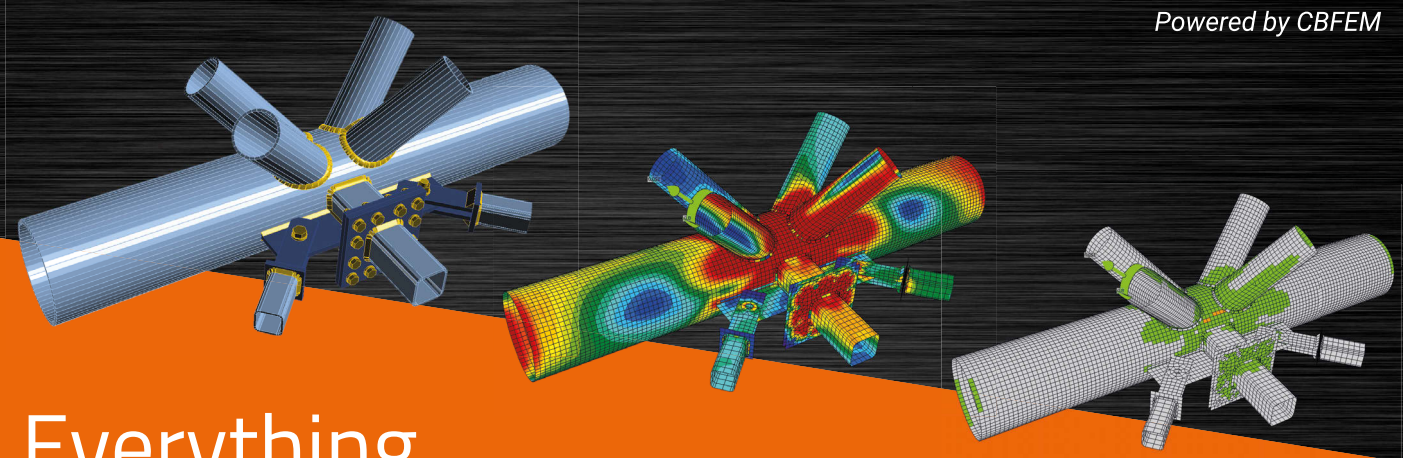

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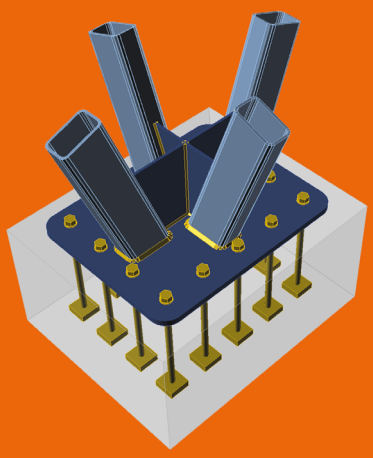

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Award for Long Span Structures

Awarded for structural engineering excellence in buildings (not bridges) incorporating particularly long spans, relative to the proportions of the structure.

Winner: Jewel Changi Airport (Singapore)

TIMOTHY HURSLEY

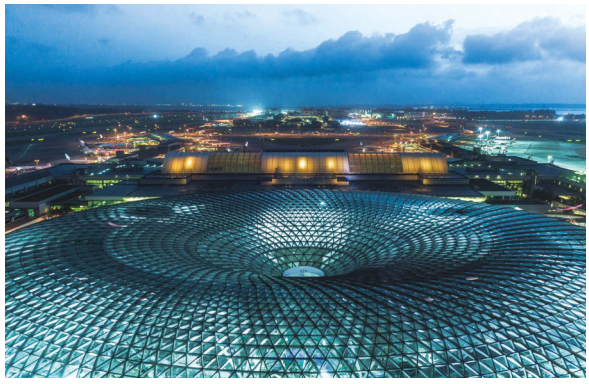
Geometrical constraints mean that each triangular glass panel is dimensionally different

PROJECT TEAM

- **Structural designer:** Buro Happold
- **Client:** Jewel Changi Airport Trust
- **Principal contractor:** Woh Hup-Obayashi Joint Venture
- **Architect:** Safdie Architects
- **MEP engineer:** Mott MacDonald
- **Lighting:** Planners Associates
- **Building and infrastructure engineer:** RSP Architects & Engineers
- **Environmental and sustainable design:** Atelier Ten
- **Water feature:** WET Design

IN BRIEF...

- The new mixed-use complex at Jewel Changi Airport in Singapore delivers an exceptional experience for the 85M passengers that will pass through it every year.
- Occupying a site of approx. 1 400 000ft², this lifestyle destination combines shopping, hotel and dining facilities as well as a tropical forest valley within a global air travel hub.
- The highlight of the airport is a massive 200m diameter glass-and-steel thin-shell gridshell that encloses the interior forest.
- At the apex of the glass roof is an oculus that showers approx. 10 000 gallons of rainwater a minute down through this spectacular central garden space.



SAFDIE ARCHITECTS

The glass-and-steel gridshell roof has a diameter of 200m

JUDGES' COMMENTS

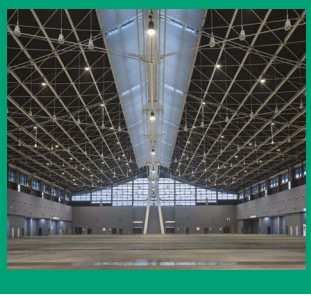
The highlight of this project is the design of the complex 200m diameter glass-and-steel thin-shell gridshell roof, which encloses an interior forest and features a 40m indoor waterfall.

The gridshell has an irregular toroidal form and is supported at the perimeter as well by 14 interior columns. The structural design responded to the geometrical constraints of the architecture and was detailed to ensure ease of fabrication and assembly.

Geometrically, the gridshell is incredibly complicated. The waterfall vortex is not central, to avoid a pre-existing airport train that runs through the area. Due to the off-centre placement, the toroid becomes slightly ellipsoidal in shape, which means each of the 9000+ triangular glass panels is dimensionally different.

In order to design intelligently and to create value, the engineers went to great efforts to carry out engineering studies and explore fabrication processes.

Commendation: Shijiazhuang International Convention and Exhibition Center (Shijiazhuang, China)
Structural designer: Architecture Design & Research Institute of Tsinghua University



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Award for Minimal Structural Intervention

Awarded for projects which through the ingenuity of structural engineering expertise have led to no, or minimal, structural intervention in order to safely prolong the life of an existing structure.

Winner: Elizabeth line OLE gantry rigorous assessments (Southeast England, UK)

PROJECT TEAM

- ➜ **Structural designer:** Buro Happold
- ➜ **Client:** Network Rail
- ➜ **Principal contractor:** Costain
- ➜ **Subcontractor**: Keltbray

IN BRIEF…

- →| The new Elizabeth line includes existing above-ground sections between Stratford and Maidenhead where new overhead line equipment (OLE) has been installed. This equipment is supported by gantries of various different types that are up to 70 years old.
- →| Initial assessment based on traditional codified approaches showed that replacement would be necessary. However, rigorous non-linear structural analysis was developed that led to the majority of the structures being safely retained.
- →| The project is noteworthy for significant programme/cost savings achieved using sophisticated engineering analysis. It is also remarkable from a sustainability point of view as a vast amount of infrastructure has been reused.

↑Walk-through inspection of existing gantries

↘Collecting material samples from boom of lattice portal

JUDGES' COMMENTS

Conventional analysis had determined that the majority of the existing structures could not be retained due to the new higher loadings, but the engineering team here took on the project and used structural engineering excellence to maximise the number of structures retained.

Through the use of detailed non-linear structural analysis, they demonstrated that a vast amount of existing infrastructure was suitable to be incorporated into the new Elizabeth line with minimal, or even no, intervention. The consequential cost and environmental savings were significant.

The judges were impressed by the rigorous assessment procedure developed and how sophisticated structural analysis methods were utilised to justify many of the existing structures and to design simple strengthening measures on others.

↑Close-up view of completed strengthening collar

FIND OUT MORE

Read more about this project in the July 2018 special issue of *The Structural Engineer*: **www.istructe.org/journal/volumes/volume-96-(2018)/issue-7/rigorous-assessment-existing-ole-gantries/**

Award for Pedestrian Bridges

Awarded for excellence in the design of pedestrian and/or cycle bridges, or other lightweight bridge structures.

Winner: Lille Langebro (Copenhagen, Denmark)

↑ Completed bridge has become important artery for pedestrians and cyclists

PROJECT TEAM

- ➜ **Structural designer:** Buro Happold
- ➜ **Client:** Realdania By&Byg
- ➜ **Principal contractor:** Mobilis Design and Construct Danmark – Hollandia Infra I/S
- ➜ **Architect:** Wilkinson Eyre
- ➜ **Specialist M&E engineer:** Eadon Consulting
- ➜ **Local engineer:** NIRAS
- ➜ **Landscape designer:** Urban Agency
- ➜ **M&E contractor:** SH Group
- ➜ **Lighting concept:** Speirs and Major
- ➜ **Specialist plate bending:** CIG

IN BRIEF…

→| The Lille Langebro is the latest movable bridge to be built across Copenhagen harbour. Its elegant design was the subject of an international competition and incorporates a complex geometry that has demanded excellence in structural design and detailing.

→| The concept was for a low-level structure inspired by the wings of a bird flapping up and down in flight. This also made sense from a structural perspective as the maximum section depth was provided at the locations of highest demand.

→| In order to maintain a slender profile in elevation, an innovative moment connection was designed to connect the moving parts together at mid-span.

→| The four bridge sections were prefabricated off site and delivered to site by sea. This approach brought improved quality in factory conditions, better safety and less susceptibility to weather delays.

→| The bridge is located in a prominent location and has already become a high-profile and important artery for pedestrians and cyclists.

↘Bridge opened for shipping

JUDGES' COMMENTS

The Lille Langebro is the latest movable bridge to be built across Copenhagen harbour, with an elegant design incorporating a complex geometry.

The bridge consists of four sections, two of which rotate in plan to provide the navigation clearance. In order to maintain a slender profile in elevation, an innovative central moment connection has been designed to connect the moving parts together at mid-span. The moment connection is achieved via paired hydraulic cylinders located within each of the two bridge box girders mounted to internal diaphragms. The upper mechanisms generate compressive resistance while the lower mechanisms generate a tensile force. When engaged in its socket, the compression mechanism also provides shear continuity and vertical alignment of the two moving spans.

The bridge sections were prefabricated entirely off site and delivered in a completed state by sea. Prefabrication in factory conditions resulted in improved quality and safety, and reduced the project's susceptibility to weather delays.

The very beautifully detailed swing bridge required close cooperation between all parties to deliver a complex structure to a high standard.

Commendation: Swing Bridge to Dinosaur Island (London, UK)
Structural designer: Arup

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Award for Small Projects of under £3M

Awarded for excellence in the structural design of projects with a construction cost of less than three million pounds.

Winner: The Viper Elevated Walkway at the Newt in Somerset (Somerset, UK)

PROJECT TEAM

- **Structural designer:** Henry Fagan & Partners
- **Client:** Mr Koos Bekker, The Newt in Somerset
- **Principal contractor:** Beard
- **Architect:** Mark Thomas Architects
- **Quantity surveyor:** Bernard James & Partners
- **Project manager:** Stonewood Design
- **Steelwork contractor, South Africa:** Prokon Services
- **Steelwork contractor, UK:** MJ Patch & Co
- **Timber work contractor:** H G Holliday

IN BRIEF...

- The Viper is a special project for many reasons, including its overall impression and sculptural beauty, and its organic shape, in an informal forest landscape.
- The winding layout of the walkway was designed to avoid all the trees in the forest canopy, and its columns supported on tripods on steel piles ensure it has minimal impact on the natural forest floor.
- There is a delicacy to all its components, and the connections in the bridge and columns were all meticulously detailed.
- The project made minimal use of materials, with all steelwork optimised for efficiency. The steelwork was hot-dip galvanised and painted with a stripe coat plus four coats of epoxy to ensure longevity.
- It required excellent coordination between the teams in Cape Town, where the superstructure was manufactured, and the UK, where the tripods were made and the walkway was erected.
- The walkway showcases structural engineering excellence and is bound to provide tremendous pleasure for thousands of visitors to the Newt, for decades to come.

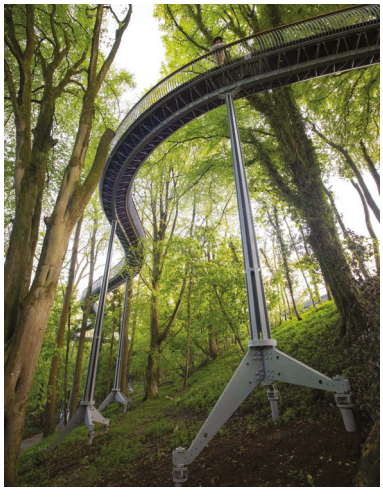
Elevated walkway glides through surrounding woodland

JUDGES' COMMENTS

This elevated woodland walkway glides through the trees. The route was planned using a comprehensive 3D cloud survey of the forest so that not a single tree would be affected.

The project team worked hard to minimise forest floor interventions. Steel piles were used rather than conventional concrete bases for the column foundations, their positions carefully chosen to avoid tree roots. Tripods above the ground were used to connect the columns onto the piles, rather than conventional pile caps, thus avoiding the use of any concrete in the forest.

The project is a charming example of how a sensitive approach and diligence during the design and construction processes can create something of enduring beauty.



Steel piles and tripods ensure minimal impact on forest floor

Commendation: Stroud Christian Community Chapel (Stroud, Gloucestershire, UK)
Structural designer: Corbett & Tasker

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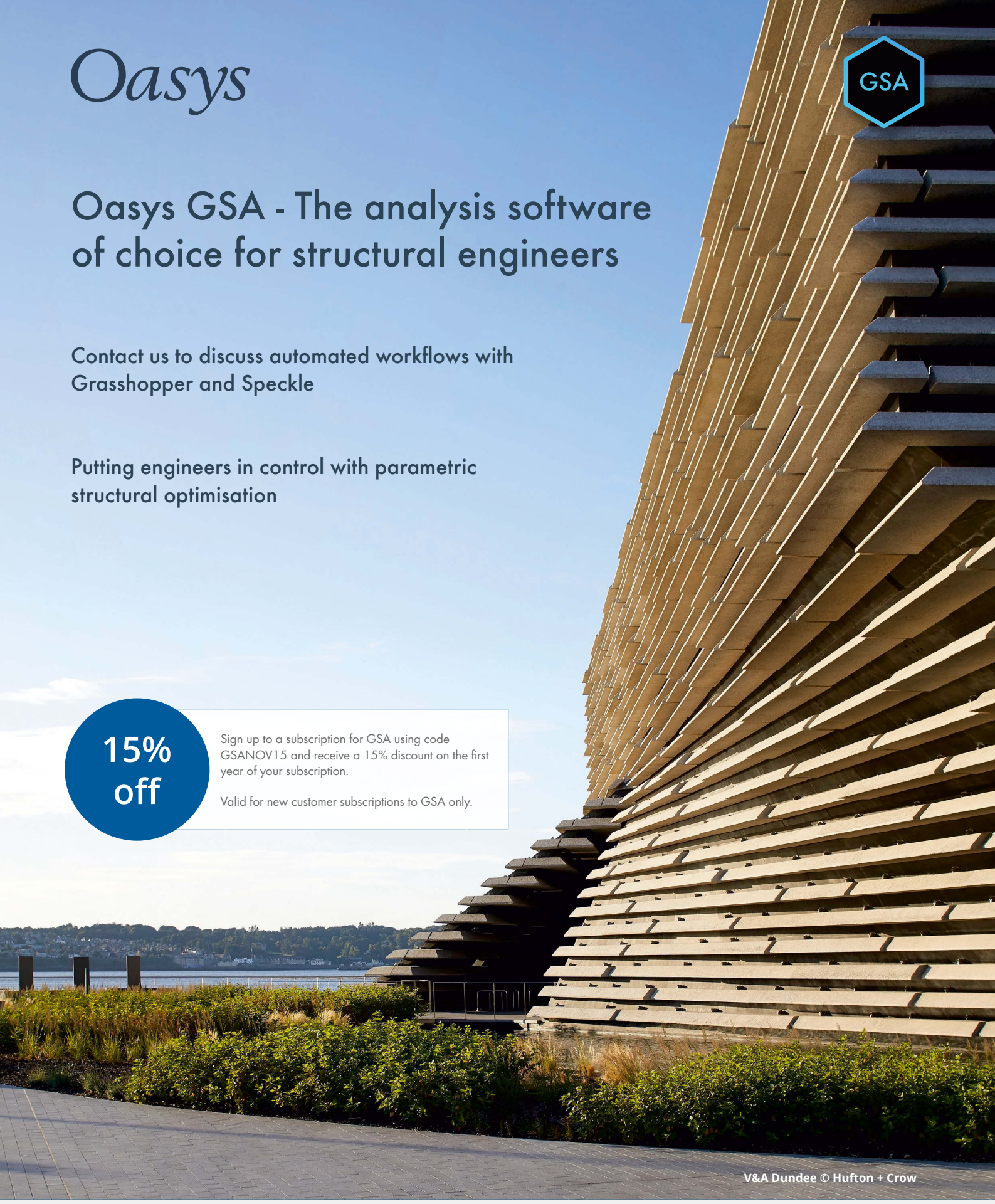

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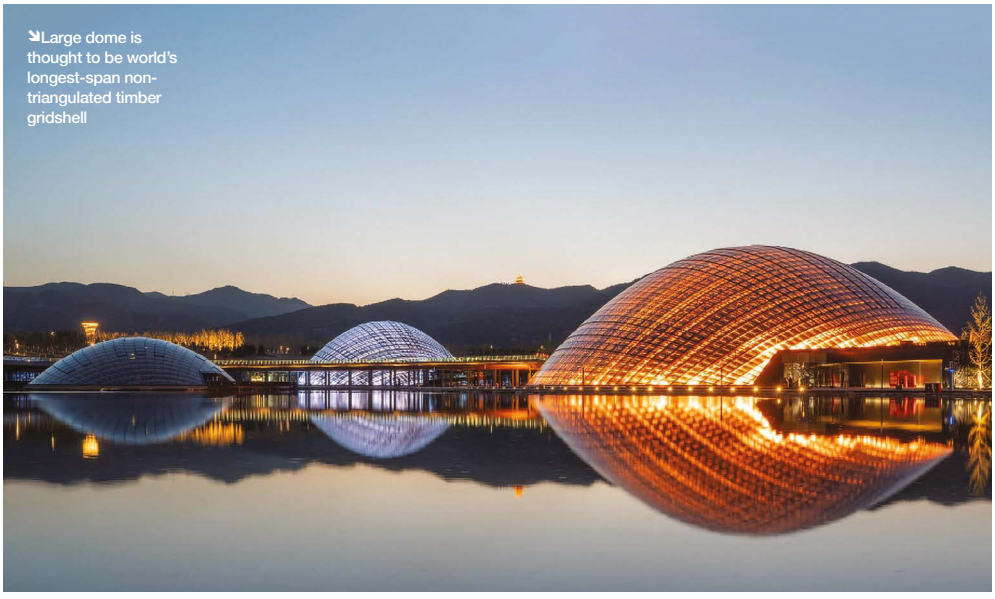
Award for Structural Artistry (building structures)

Awarded for building projects in which an adequate and worthy solution has been transformed by the vision and skill of the structural engineer into something exceptional.

Winner: Taiyuan Botanical Garden Domes (Taiyuan, Shanxi Province, China)



↘Large dome is thought to be world's longest-span non-triangulated timber gridshell

PROJECT TEAM

- **Structural designer:** StructureCraft
- **Structural designer/local design institute:** Arcplus Institute of Shanghai Architectural Design & Research (Co., Ltd)
- **Client:** Taiyuan Botanical Garden
- **Principal contractor:** Greenland Construction Group (Co., Ltd.) & Shanghai SKF Architecture Technology Co., Ltd.
- **Architect:** Delugan Meissl Associated Architects & Valentien+Valentien Landschaftsarchitekten und Stadplaner SRL
- **Structure concept design consultant:** Bollinger+Grohmann
- **Glass curtain wall construction:** Shanghai Beelitech Co. Ltd
- **Glulam joints, components and material characteristics experiments:** StructureCraft & Tongji University
- **Glulam structural health monitoring:** Taiyuan University of Technology

↘Single-layer, curved, post-tensioned cable net provides additional stiffness to glulam structure

IN BRIEF…

- The new botanical garden complex in Taiyuan, China features three long-span timber gridshells which function as greenhouses. Each dome in the gardens features a different biome: aquatic, desert and tropical.

- The domes range from 11m to 29m in height and 43m to 88m in diameter. The large dome is thought to be the world's longest-span non-triangulated timber gridshell.
- All three parabolic gridshells comprise doubly curved glulam beams, arranged in two or three crossing layers. When viewed from above, the timber structures resemble seashells, with the primary members closely bunched on one side and then fanned out across the surface of the domes.
- The buckling performance of these slender shells was critical, and significant full-scale structural testing was conducted in Canada and China to prove the stiffness and capacity of unique hidden connections which were developed to create rotational and shear stiffness in the two- and three-layer gridshells.

JUDGES' COMMENTS

The Taiyuan Botanical Garden complex features three paraboloid domes with spans of up to 88m constructed through a complex structural system of timber beams, overlapped in two directions, and stainless steel cables. It is thought to be the largest-span structure of its kind in the world.

The complex geometry inherent in this architectural form made parametric design and structural optimisation of paramount importance. The careful planning of the design, fabrication, transportation, and construction sequence resulted in a problem-free erection on site with very little site alteration required.

The concept is based on land restoration and the choice of materials creates a harmony between nature, architecture and structure. The project pushes the boundaries of structural engineering, materiality and construction technique.

Award for Structural Artistry (non-building structures)

Awarded for creative structures in which the vision and skill of the structural engineer has been paramount. Structures may include but are not restricted to sculptures, demonstrator projects, motorway gantries, floating structures, moving structures and cranes.

Winner: Future Tree (Esslingen, Switzerland)

© BASLER & HOFMANN AG / STEFAN KUBLI

PROJECT TEAM

- ➜ **Structural designer:** Basler & Hofmann AG
- ➜ **Client:** Basler & Hofmann AG
- ➜ **Principal contractor:** Erne AG Holzbau
- ➜ **Architect:** Gramazio Kohler Research, ETH Zurich
- ➜ **Support structural engineering – timber construction:** SJB Kempter Fitze AG
- ➜ **Co-development of construction method and fabrication – concrete column:** Chair of Physical Chemistry of Building Materials, ETH Zurich
- ➜ **Architect – office extension:** Stücheli Architekten AG

IN BRIEF...

- →| The Future Tree is an open, free-form outdoor pavilion that attracts attention with its expressive form and unusual combination of materials.
- →| The project made systematic use of parametric design and planning methods in combination with new digital fabrication methods.
- →| The digitally fabricated crown is made of 380 timber elements. The frame's geometry plays with the opening of the reciprocal knots to achieve a higher stiffness in the cantilevering part.
- →| For the reinforced concrete column, 3D-printed formwork was combined with a fast-hardening concrete.
- →| The project demonstrates the potential of digital technologies to develop a new design language, optimise functionalities and reduce construction waste.

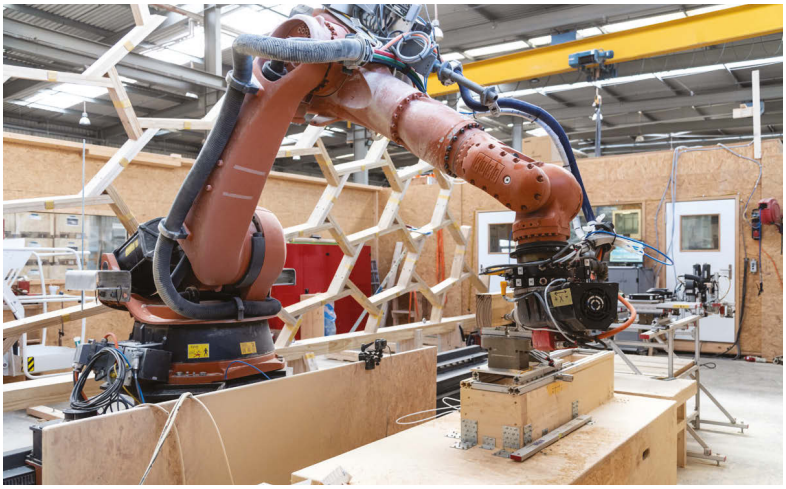
JUDGES' COMMENTS

The innovative canopy of this elegant, doubly curved, outdoor pavilion is the result of an efficient use of timber, 3D software and seamless collaboration.

The systematic use of parametric design and planning methods, in combination with new digital fabrication methods, made it possible to optimise functionality while minimising the use of resources and construction waste.

This successful pilot project demonstrates the potential of new digital planning and fabrication methods on a cost-efficient basis with improved sustainability. In an intensive collaboration process, all project participants experienced how an integral, digital design-to-assembly process changes the way architects, engineers and manufacturing companies work together.

↑ Future Tree's eye-catching canopy comprises 380 timber elements



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➜ Industrial robot pre-drilling timber structure

Award for Structural Heritage

Awarded for excellence in structural design where important heritage characteristics of the original structure are preserved through appropriate restoration and conservation.

Winner: Christchurch Town Hall (Christchurch, New Zealand)

↘ Circular stage for Christchurch Symphony Orchestra

PROJECT TEAM

- ➜ **Structural designer:** Holmes Consulting
- ➜ **Client:** Christchurch City Council
- ➜ **Principal contractor:** Hawkins Construction
- ➜ **Architect:** Warren and Mahoney
- ➜ **Project director:** Holmes Consulting
- ➜ **Senior geotechnical engineer:** Tonkin and Taylor Ltd
- ➜ **Commercial manager:** Rider Levett Bucknall

IN BRIEF…

- →| Acclaimed for its architecture and acoustics, Christchurch Town Hall holds a special spot in Cantabrian hearts. Its position at the centre of the new Performing Arts precinct reinforces its status as a premier event space.
- →| As a result of the devasting 2010 and 2011 earthquakes, and due to the land damage beneath, this project required the strengthening of foundations and damage repair to the original design.
- →| For Holmes Consulting, this NZ $167M+ conservation project was both technically complex and interesting. With significant portions being upgraded, repaired and restored – and additional areas undergoing a complete rebuild – the project offered the full spectrum of structural and geotechnical challenges.
- →| Using high-end analysis, the team minimised the strengthening work required for the superstructure to achieve a 100%NBS seismic rating. In addition to this excellent engineering, the team also aimed to preserve the original character and style of the building.

↗ Works in progress to create stage

JUDGES' COMMENTS

Acclaimed for its architecture and acoustics, Christchurch Town Hall is a local landmark. Following devastating earthquakes in 2010 and 2011, the original building required significant structural repair and strengthening of the supporting foundations.

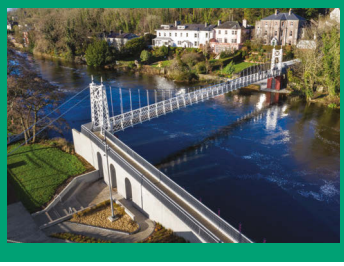
This conservation project demanded a full spectrum of technically complex structural and geotechnical solutions. Ground stabilisation issues were solved and the future performance of the structure and foundations was predicted through detailed analysis and intensive co-ordination between the geotechnical and structural engineers.

Complex analysis was employed to minimise the strengthening work required for the superstructure. The result preserves the original character and style of the building and protects the existing fabric – a positive both for sustainability and the client.

This project is an excellent example of what structural engineers can bring to a devastated existing building. By understanding its behaviour and failure, the team was able to repair and preserve this important structure.

Commendation: Repair and rehabilitation of Daly's (Shakey) Bridge (Cork, Republic of Ireland)

Structural designer: RPS Consulting Engineers Ltd



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Award for Structural Transformation

Awarded to projects demonstrating structural engineering excellence in the transformation, repurposing or extension of an existing building or structure.

Winner: Ashworth Centre and Library extension – Lincoln's Inn Fields (London, UK)

New double basement adjacent to Great Hall

PROJECT TEAM

- **Structural designer:** Eckersley O'Callaghan
- **Client:** The Honourable Society of Lincoln's Inn Fields
- **Principal contractor:** Graham Construction
- **Architect:** MICA
- **M&E consultant:** Mott MacDonald
- **Quantity surveyor & CDM co-ordinator:** Gardiner & Theobald
- **Planning consultant:** Montagu Evans
- **Acoustic consultant:** Sandy Brown Associates
- **Fire engineer:** Jeremy Gardner Associates
- **Landscape architect:** Jeremy Rye Studio

IN BRIEF...

- The Honourable Society of Lincoln's Inn Fields is home to the Grade II* listed Great Hall and Library building completed in 1845 and the 1870s by architect Philip Hardwick.
- A major recent refurbishment included a 3000sq.ft extension to the existing Library building separated by a glass link, and the addition of two cavernous basement spaces totalling 20 000sq.ft and linked directly to the historic building via new subterranean apertures.
- Obtaining planning permission for such an intervention on this iconic site required a thoroughly measured approach with contention across the council committee, client and tenants.
- This sprawling project presented challenges across a range of materials and scale. Safeguarding the historic building was at the forefront of the engineers' minds, but there were many more subtleties to a sympathetic response to the reconfigured architecture.
- Numerous junctions with the existing buildings were carefully detailed to allow the two to freely articulate without visual disruption.

JUDGES' COMMENTS

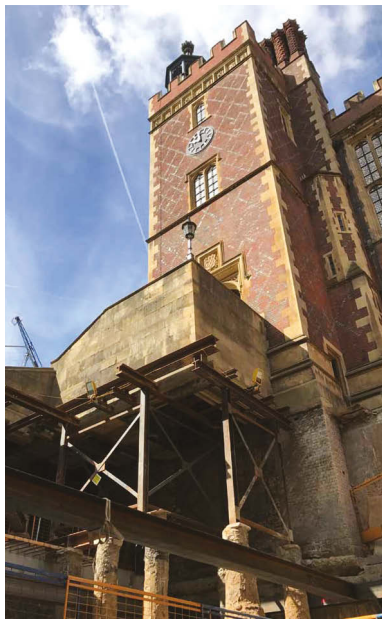
The structural interventions carried out at Lincoln's Inn Fields seamlessly weave two new buildings into the fabric of the original 1845 building.

Although much of the engineering efforts were in the new construction of a basement and extension building, the most challenging aspects were related to the complexity at the junctions of the modification of the existing building, to make best use of the space and to create the connectivity required by the client.

In these works, the engineers safeguarded the heritage and natural environment, taking time to painstakingly understand the buildings' structural intricacies, resolve the structural interfaces, and make those junctions invisible while carefully monitoring the buildings throughout the works.

The visible scale of the new buildings and finished project belies a significant feat of engineering below the ground and behind the scenes.

> **"THE MOST CHALLENGING ASPECTS WERE RELATED TO THE COMPLEXITY AT THE JUNCTIONS OF THE MODIFICATION OF THE EXISTING BUILDING**



Supporting existing granite entrance staircase during construction of new basement underneath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Award for Structures in Extreme Conditions

Awarded for excellence in the design of structures subject to extreme actions or involving unusually complex interactions with the ground and/or particularly challenging foundations.

Winner: Atrio North Tower (Bogotá, Colombia)

PROJECT TEAM

- **Structural designer:** Arup & PYD (Engineer of Record)
- **Client:** Grupo A, QBO
- **Principal contractor:** ARPRO Arquitectos Ingenieros S.A. & EllisDon Construction Services Inc.
- **Architect:** Rogers, Stirk, Harbour + Partners & El Equipo Mazzanti
- **MEP engineer:** Arup & POCH (Engineer of Record)
- **Quantity surveyor:** AECOM
- **Steel contractor:** Supermetal Structures & TECMO, HB
- **Cladding contractor:** Permasteelisa Group
- **Formwork:** Peralta

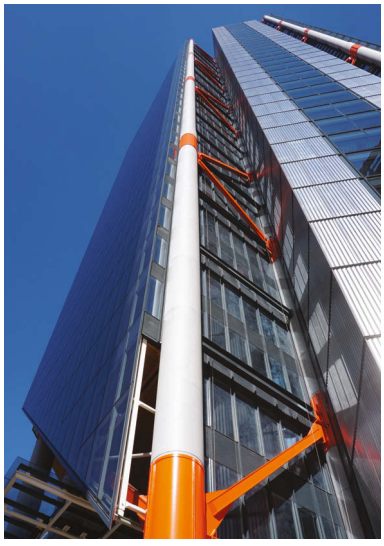
IN BRIEF…

- The Atrio project has a scale and ambition which is unprecedented in Colombia. Rising over 200m, and set against the ridges of the Andes, the striking architecture of North Tower is symbolic of a brighter future for Colombia while also being a remarkable integrated engineering solution that responds to a challenging and highly seismic site.
- The structural design resolves complex technical challenges which have required both research and construction collaboration to realise an architecturally expressed, and highly efficient, composite braced frame.
- At 46 storeys, and with a total development area of 120 667m^2, it is the tallest office building in Colombia. The envelope tapers inwards at ground level, creating Bogotá's largest privately funded public space.
- North Tower represents an exemplar for sustainable high-rise design from the wider socioeconomic aims of the project's vision to the advanced seismic design techniques used to minimise the building's embodied carbon.

↗ Atrio North Tower is tallest office building in Colombia

JUDGES' COMMENTS

This ambitious project is the tallest office building in Colombia. The structure represents a technological advancement in the field of composite high-rise construction, combining state-of-the-art steel construction with local concrete practice to deliver innovation economically in a highly seismic site.



➔ Seismic design approach is continuous braced tube that mobilises all perimeter columns

The seismic-resisting function was central to the building's architecture and led to the development of a sophisticated, highly ductile, composite braced frame. Maximising ductility was a key factor in counteracting seismic effects and reducing material use. The bracing elements were designed to deform plastically during design-level earthquake events.

The project also leaves a positive legacy for local steelwork capability. Thanks to upskilling of local labour to carry out erection and field welding of special seismic connections, the local market now has the capability to deliver projects of a similar scale and specification without importing these elements.

A remarkable all-round combination of structural engineering design expertise, elegant detailing, and value in a very challenging location.

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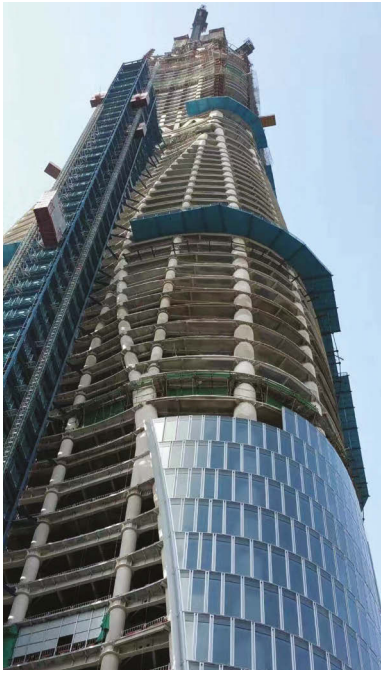
Award for Tall or Slender Structures

Awarded for structural engineering excellence in projects where height or slenderness presents a particular structural challenge in the design and construction.

Winner: Tianjin CTF Finance Centre (Tianjin, China)

PROJECT TEAM

- **Structural designer:** Skidmore, Owings & Merrill and ECADI
- **Client:** New World China Land Limited Project Management Department
- **Principal contractors:** CSCEC, JANGHO & Netfortune
- **Architect:** Skidmore, Owings & Merrill and ECADI (local design institute)
- **Executive architect:** Ronald Lu and Partners (International) Ltd
- **Wind tunnel testing:** BMT
- **MEP engineer:** WSP (Asia) Limited
- **Lighting consultant:** Isometrix Lighting Design
- **Facade engineer:** Arup
- **Acoustics:** Campbell Shillinglaw Lau Ltd



SOM

↑3D software allows use of complex geometries such as sloping column system with minimal impact on fabrication

IN BRIEF…

- A dramatic, undulating profile distinguishes this 530m tall tower as a new landmark in the growing Tianjin Economic-Technological Development Area (TEDA). The tower's design is a synthesis of architectural, structural and functional requirements.
- The primary structural innovation for the tower was the use of a system of 'soft-braces' consisting of variable sloped columns that were configured to simultaneously optimise the structural performance for both the frequent and the rare seismic events.
- The mixed-use tower contains high-end offices, apartments and a five-star hotel, arranged to match the optimum spans for each of these uses – with longer-lease spans for the office floors, and shorter spans to maximise views at the apartment and hotel levels.

JUDGES' COMMENTS

This 530m tall tower is a striking fusion of structural and architectural expression. It boasts an innovative structural system and excellent optimisation of form.

Working from the bottom up and from the core outward in a core-to-envelope approach, the team put in great efforts to mitigate all challenges. It is located in an area of high seismicity, but the structure utilises a sloping column system of 'soft braces' to significantly enhance the seismic performance of the building.

Wind tunnel studies informed and optimised the building's aerodynamic shape and minimised wind loads.

A team approach, which included close collaboration with the client, and tight coordination with local architects, engineers and consultants, sets the standard for successful large-scale, super-tall engineering.

↘ Tianjin CTF Finance Centre's design is fusion of structural and architectural expression

SETH POWERS / SOM

FIND OUT MORE

Read more about this project in the September 2018 issue of *The Structural Engineer*: **www.istructe.org/journal/volumes/volume-96-(2018)/issue-9/tianjin-ctf-finance-centre-wind-form-structure/**

Award for Vehicle Bridges

Awarded for excellence in the design of bridges carrying highways and/or railways.

Winner: Rose Fitzgerald Kennedy Bridge over the River Barrow (Wexford and Kilkenny, Republic of Ireland)

ROYSTON PALMER

PROJECT TEAM

- **Structural designer:** Arup & Carlos Fernandez Casado S.L.
- **Client:** Transport Infrastructure Ireland
- **Principal contractor:** BAM Civil Ltd & Dragados Ireland Ltd
- **Architect:** Carlos Fernandez Casado S.L.
- **Concept design and aesthetics:** Mott MacDonald & Ron Yee
- **Road safety auditor:** PMCE Consultants
- **Third-party checker:** Eptisa & Siegrist y Moreno Engineering Ltd
- **Ecologist:** Flynn Furney Environmental Consultants

IN BRIEF…

- The Rose Fitzgerald Kennedy Bridge is one of the most iconic structures in Ireland. This nine-span, three-tower extradosed bridge comprises a single central plane of cables supporting four traffic lanes.
- At 887m between expansion joints, the bridge is considered the longest in Ireland, while the two main spans of 230m each are the longest post-tensioned extradosed concrete spans in the world.
- Strengthening connections between communities and enhancing the quality of life in New Ross town, previously frequently congested with traffic, this modern 21st century landmark was designed to be sympathetic and complementary to its surroundings and environment.

↑Rose Fitzgerald Kennedy Bridge is one of most iconic structures in Ireland

↘During construction, bridge featured world's longest balanced cantilever for concrete-deck extradosed bridges

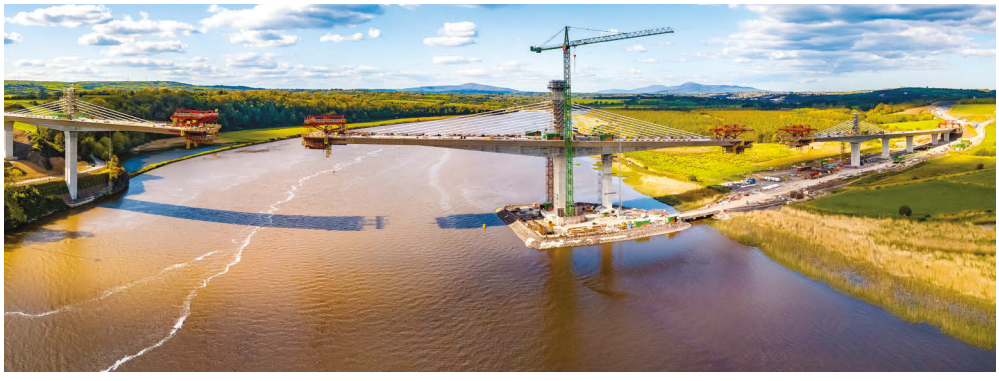
JUDGES' COMMENTS

The 887m long, nine-span, three-tower extradosed concrete bridge rises 36m over the water to provide navigational clearance for access to the Port of New Ross. The structure is impressive in scale and slenderness. It holds multiple records, including the longest bridge in Ireland, the longest concrete extradosed spans in the world and, during construction, the longest balanced cantilever for concrete-deck extradosed bridges in the world.

To reduce materials required, high-strength concrete was used, and precast panels were introduced on the cantilevers to minimise the cross-section weight. A long service life is ensured through careful detailing and specification of materials, with provision for structural health monitoring systems and maintenance.

State-of-the-art structural analysis tools, such as explicit time-dependent creep curves and step-by-step non-linear iterative analysis, were used during the complex construction. The result is a highly optimised structural design and statement piece of engineering.

> "THE RESULT IS A HIGHLY OPTIMISED STRUCTURAL DESIGN AND STATEMENT PIECE OF ENGINEERING



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Award for Zero-Carbon Ambition

Awarded for projects which demonstrate excellence in the pursuit of low-, zero-, or negative-carbon solutions across the design and construction of the project.

Winner: York House (London, UK)

PROJECT TEAM

- **Structural designer:** Webb Yates Engineers
- **Client:** The Office Group
- **Principal contractor:** Collins Construction
- **Architect:** dMFK
- **Project manager:** Quantem
- **M&E engineer:** EEP
- **Planning consultant:** Lichfields
- **Sustainability consultant:** EB7
- **Transport consultant:** Caneparo
- **Arboriculturalist:** Ian Keen Ltd
- **CLT contractor:** Eurban

IN BRIEF…

- Situated in the heart of Kings Cross, York House is an eight-storey refurbishment and extension scheme providing flexible co-working space for The Office Group.
- The existing building was one of the earliest office blocks built on Pentonville Road. Although it stands in a prominent location with a triple-aspect outlook, the building was not in use due to the deterioration of the facade and dimly lit, poorly ventilated internal spaces.
- The existing building was refurbished across all floors, providing meeting rooms, open-plan areas, reception, cafe, bike storage and changing facilities.
- A new lightwell was added at the front of the building, to make the existing basement usable as office space. A new CLT extension was also added at the front, as well as an extension of the existing building at roof level with a CLT structure, providing flexible working spaces.

JUDGES' COMMENTS

Intelligent and sustainable structural design are at the heart of this eight-storey refurbishment and extension scheme, which breathes new life into a highly deteriorated commercial building. The existing building was utilised for support, circulation and facilities, and the existing foundations were justified for the additional weight of the extension.

Five-storey feature extension at front of building champions use of engineered timber

AGNESE SANVITO

A five-storey feature extension was added to the front of the building, championing the use of engineered timber to provide an efficient and sustainable structural solution. Exposing the timber structure internally reduced the amount of finishes required, further reducing both cost and carbon.

A new lightwell was added to enable the transformation of the existing basement into office space, maximising the potential of the existing building.

This thoughtful project demonstrates what is possible when sustainability is put at the top of the agenda, combining significant low-carbon interventions with the intelligent reuse of an existing building.

Existing building was also extended at roof level with new CLT structure

Commendation:

Oregon Forest Science Complex (Corvallis, Oregon, USA)

Structural designer:
Equilibrium Consulting Inc.

JOSH PARTEE

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IMAGES SHOW PROJECTS BY WALKER DENDLE TECHNICAL RECRUITMENT CLIENTS SHORTLISTED FOR THE STRUCTURAL AWARDS 2013–2021

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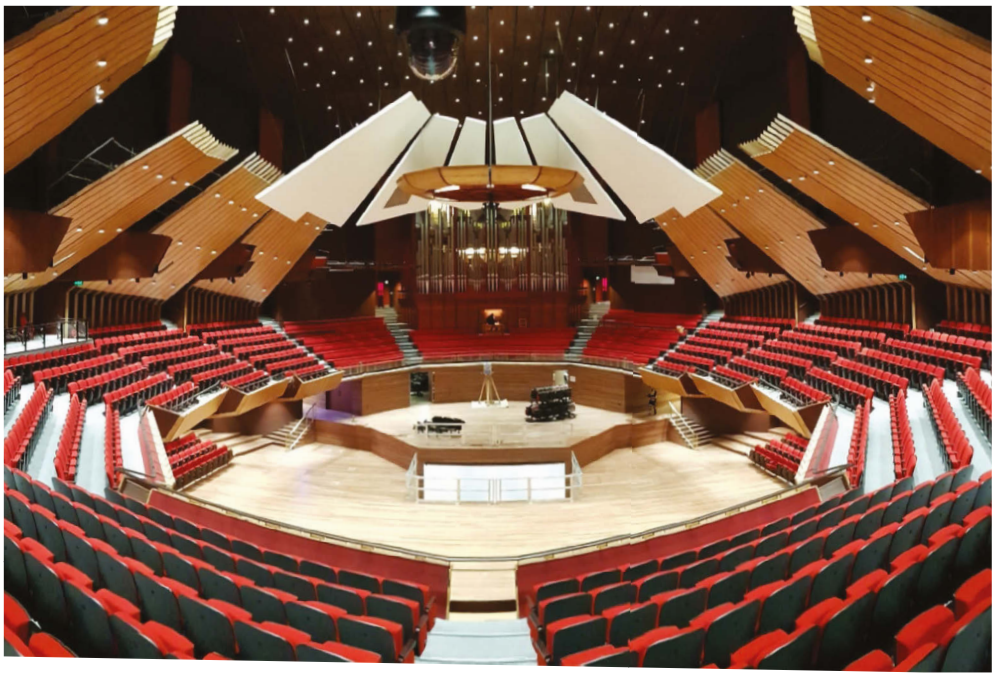
Supreme Award for Structural Engineering Excellence

Winner: Christchurch Town Hall (Christchurch, New Zealand)



PROJECT TEAM

- **Structural designer:** Holmes Consulting
- **Client:** Christchurch City Council
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IN BRIEF...

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- As a result of the devasting 2010 and 2011 earthquakes, and due to the land damage beneath, this project required the strengthening of foundations and damage repair to the original design.
- For Holmes Consulting, this NZ $167M+ conservation project was both technically complex and interesting. With significant portions being upgraded, repaired and restored – and additional areas undergoing a complete rebuild – the project offered the full spectrum of structural and geotechnical challenges.
- Using high-end analysis, the team minimised the strengthening work required for the superstructure to achieve a 100%NBS seismic rating. In addition to this excellent engineering, the team also aimed to preserve the original character and style of the building.

↑Circular stage for Christchurch Symphony Orchestra

↓ FRP wrapping of beam joint following selective weakening

JUDGES' COMMENTS

When the devastating earthquakes hit Christchurch in 2010 and 2011, the Town Hall was severely damaged, and was considered to be dangerous with uncontrolled hazards. It might have been so easy to decide that this important building was irreparable. But this was not the decision taken by the engineers. They were determined to restore this 1970s building to its original grandeur, by ensuring it could be rated to 100% New Building Standard (NBS) to resist any future seismic events.

Investigations into the level and extent of damage, and considerations of seismic-related strengthening schemes, were both launched simultaneously. Liquefaction of the soil, coupled with settlement and lateral drift of the foundations, had been key to the damage which was sustained. Collaboration between geotechnical and structural engineers lay at the heart of innovations to intervene as little as possible, in targeted ways, to allow NBS to be achieved. This included controlled local demolition of various components, which had to be modelled carefully for sequencing reasons.

This project truly represents the art of the possible. The engineers knew that the building could be salvaged, and they achieved just this through applying their skills.

> **"THIS PROJECT TRULY REPRESENTS THE ART OF THE POSSIBLE**

Supreme Award for Structural Engineering Excellence

Winner: Lille Langebro (Copenhagen, Denmark)

PROJECT TEAM

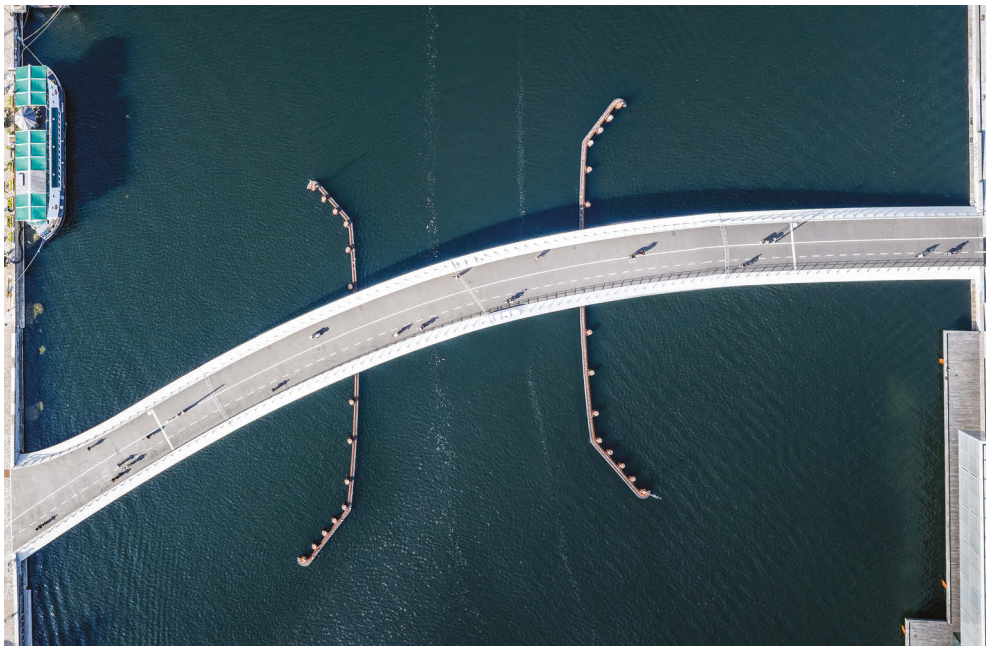
- **Structural designer:** Buro Happold
- **Client:** Realdania By&Byg
- **Principal contractor:** Mobilis Design and Construct Danmark – Hollandia Infra I/S
- **Architect:** Wilkinson Eyre
- **Specialist M&E engineer:** Eadon Consulting
- **Local engineer:** NIRAS
- **Landscape designer:** Urban Agency
- **M&E contractor:** SH Group
- **Lighting concept:** Speirs and Major
- **Specialist plate bending**: CIG

IN BRIEF…

- The Lille Langebro is the latest movable bridge to be built across Copenhagen harbour. Its elegant design was the subject of an international competition and incorporates a complex geometry that has demanded excellence in structural design and detailing.
- The concept was for a low-level structure inspired by the wings of a bird flapping up and down in flight. This also made sense from a structural perspective as the maximum section depth was provided at the locations of highest demand.
- In order to maintain a slender profile in elevation, an innovative moment connection was designed to connect the moving parts together at mid-span.
- The four bridge sections were prefabricated off site and delivered to site by sea. This approach brought improved quality in factory conditions, better safety and less susceptibility to weather delays.
- The bridge is located in a prominent location and has already become a high-profile and important artery for pedestrians and cyclists.

JUDGES' COMMENTS

Lille Langebro is an extraordinary bridge which crosses the Copenhagen harbour. Its double-curvature geometry flows with structural need, gracefully.



↑Aerial view of Lille Langebro showing four sections of moving bridge

> **A BEAUTIFULLY CRAFTED BRIDGE, IN WHICH THE SKILL OF THE STRUCTURAL ENGINEER IS CELEBRATED PERMANENTLY**

A swing bridge, it has a wonderful structural innovation up its sleeve – where the segments meet at mid-span when operational as a bridge, the structural engineers have managed to create a moment- and shear-carrying joint through a clever hydraulics-based scheme. This has the great benefit of stiffening the deck and reducing vibrations while retaining the possibility of temperature movements.

Coupled with this, the mechanisms for opening the bridge are hidden in chambers in the deck, and they are quiet. Cost, carbon, constructability and deconstructability were all key drivers, as was robustness of design, particularly against impact from ships or ice flows. Not easy to satisfy all these criteria, and to retain such beauty. But this is exactly the outcome.

This new addition to Copenhagen allows 40 000 cyclists daily to commute over a beautifully crafted bridge, in which the skill of the structural engineer is celebrated permanently.

↘ Bridge is new landmark for Copenhagen