Winners and commendations

AWARDS SPECIAL

StructuralAwards2019

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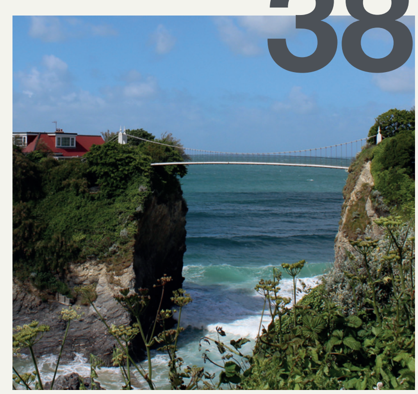
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JUDGING PANEL

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.

JUDGING PROCESS

The judging process comprises three stages:

1) A panel of eminent judges independently reviews all entries and awards points based on evidence of the judging criteria.

2) The highest-scoring entries are evaluated by a 'sitting judging panel' to establish the shortlist.

3) An 'invited judging panel' meets to decide category winners. The final panel consists only of judges who do not have a potential conflict of interest with any of the shortlisted projects.

JUDGING CRITERIA

The judges review entries against the following criteria:

1) Creativity and innovation

2) Elegance and good detailing

3) Sustainability

4) Value

5) Ease of constructability

Kayin Dawoodi

Kayin is a Senior Structural Engineer and Business Developer at Sweco Sweden. With architectural roots and a passion for the unusual, he focuses on extraordinary projects and structures, requiring divergent and innovative approaches to design. Kayin was also co-founder of Bridges to Prosperity's UK Charitable Trust.

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.

Prof. Ding Jiemin

Prof. Ding is Chief Engineer of Tongji Architectural Design Co., Ltd. Throughout his career, he has been dedicated to excellence in structural engineering design. Prof. Ding specialises in steel structures, super-high-rise buildings and long-span complex structural systems. He was awarded the Institution of Structural Engineers Gold Medal in 2018.

Daniel Dowek

Daniel spent his early career at Price & Myers in London, where he developed a specialism in conservation, enjoying work on a variety of buildings with historic significance. He won the Institution's Young Structural Engineering Professional Award in 2018, and is currently at Equilibrium Consulting, a timber engineering firm in Vancouver.

Paul Fast

Since establishing his own structural engineering consultancy in 1985, Paul has had the opportunity to work 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.

Ian Firth

Ian is a world-leading expert in bridge design and construction, and also a leading advocate of bridge-building charity Bridges to Prosperity. He is a Past President of the Institution of Structural Engineers.

Tristram Hope

Tristram is the founder and Chairman of independent construction consultancy THiSolutions Ltd, with particular expertise in sustainable design. He is the Royal Academy of Engineering Visiting Professor in Engineering Design and Sustainability for the School of Civil Engineering at the University of Leeds.

Martin Knight

Martin is one of the leading UK architects specialising in the design of bridges and transport infrastructure. He founded international bridge designers Knight Architects in 2006. His practice has completed more than 30 bridges in the UK and internationally, including the iconic Lower Hatea River Crossing in New Zealand.

Toby Maclean

Toby is a structural engineer and Principal at Entuitive, an international consulting engineering practice with offices in the UK, Canada and the USA. He previously founded TALL Engineers, an award-winning structural engineering consultancy known for providing practical yet technically sophisticated solutions to diverse projects.

Michelle McDowell

Michelle is a Principal at BDP, with over 30 years' experience of design and delivery of many challenging, innovative and award-winning projects. She was awarded an MBE for services to the construction industry in 2010, and made a Fellow of the Royal Academy of Engineering in 2011.

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 the Engineering Leadership Group.

Simon Pitchers

Simon has over 40 years of construction industry experience. He is a consultant and joint founder of Craddys, a 60-strong structural and civil engineering consultancy. Simon is also a Director of Arc Bauen, construction managers, a member of the Institution's Editorial Advisory Group, occasional speaker and media commentator.

Sam Price

Sam founded Price & Myers with Robert Myers in 1978. He has designed many award-winning new buildings, with a particular interest in theatres and concert halls. He has also advised on a number of cathedrals, and is a member of the Cathedral Architects Association.

Julia Ratcliffe

Julia is an independent structural engineering consultant and founded scale consulting in 2018 after seven years as a Director of Expedition Engineering. In her 25-year career, she has worked for consultancies in the UK and overseas, as well as with international development organisations.

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 won the Royal Academy of Engineering Silver Medal in 2010.

Nick Russell

Nick is a Director at Thomasons, an 80-strong organisation of consulting engineers specialising in civil and structural engineering, glass engineering and building surveying. He has a passion for conceptual design and in making structures as effective as possible. Nick is a Past President of the Institution of Structural Engineers.

Su Taylor

Su is 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 design creativity in the next generation of structural engineers. Su is Vice-President of the International Society for Structural Health Monitoring of Intelligent Infrastructure.

Peter Terrell

Peter is founder and President of Terrell Group Consulting Engineers. After early years with Ove Arup, Peter set up as a 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.

Sponsored by **Griffiths & Armour**

Supreme Award for Structural Engineering Excellence

For the finest example of excellence in structural engineering design selected by the judges from the winners of the 12 principal award categories.

Winner: New Tottenham Hotspur Stadium (London, UK)
Structural engineer: BuroHappold Engineering and Schlaich Bergermann Partner

© HUFTON+CROW

↑ New Tottenham Hotspur Stadium includes complex cable-net roof and long-span structures to accommodate retractable pitch

> **"THE STRUCTURAL INNOVATION IS EVIDENT IN THE SLIDING PITCH, VAST OPEN CONCOURSES AND ALMOST IMPOSSIBLY LIGHT ROOF**

PROJECT TEAM

- **Client:** Tottenham Hotspur Football Club
- **Principal contractor:** Mace
- **Architect:** Populous
- **Retractable pitch:** Nick Cooper & SCX
- **PT scheme design:** Truby Stephenson
- **Detailed PT design:** Walsh
- **Final design of sliding pitch steel structure:** COWI
- **Steelwork:** Severfield UK
- ***In situ* concrete frame:** Morrisroe

IN BRIEF…

→| The New Tottenham Hotspur Stadium project involved the redevelopment of the old White Hart Lane football ground into a 62 062-seat, football-focused, multipurpose stadium able to host NFL matches.

→| An elegant cable-net roof and asymmetrical bowl design are focused towards the south, where the 17 500-seat south stand, or 'home end', creates the heartbeat of the stadium.

→| The stadium incorporates a retractable pitch, with 2090m of rails installed to allow the pitch to move in three sections. These take 25mins to fully slide beneath the south stand.

→| The south stand contains 7217t of steel in three main spans, including feature 'tree columns' which allow the retractable pitch trays to slide beneath. Extensive transfer structures span the retracting pitch sections.

→| The club's desire for open spaces drove the use of post-tensioned (PT) concrete slabs, which resulted in 40% fewer concrete columns (approx. 1100 versus 1830).

→| 55 000m^3 of site-won aggregate was washed and used to produce 120 000m^3 of concrete for the lower-level structure, which saved an estimated 551 200 heavy-truck miles, equating to a CO_2 saving of 732 860kg.

→| BuroHappold provided all engineering disciplines on the project, including structural engineering for the primary building structures. The final detailing of the cable-net roof was by Schlaich Bergermann Partner.

JUDGES' COMMENTS

The structural innovation of the New Tottenham Hotspur Stadium is evident in the sliding pitch, vast open concourses and almost impossibly light roof.

In all areas, control of vibration was a key issue, and participatory design was used to convince the client and design team that the light design was feasible.

What might otherwise have been a heavy, bending-dominated structural form for the roof was instead transformed by the structural engineers into a light, looped cable net, with an outer compression ring and two inner tension rings.

With no horizontal bracing, any horizontal or uneven loading is carried by geometric stiffness only.

The judges felt that the sheer elegance of structural form, light-touch use of resources and outstanding detailing evident in key connections all pointed to a structural design worthy of the 2019 Supreme Award for Structural Engineering Excellence.

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: CITIC Tower (Beijing, China)
Structural engineer: Arup and Beijing Institute of Architectural Design (Group) Co., Ltd

PROJECT TEAM

- **Client:** CITIC HEYE Investment Company
- **Principal contractor:** China Construction Third Engineering Bureau Group Co., Ltd
- **Architect (concept):** TFP Farrells
- **Architect (design):** Kohn Pedersen Fox Associates
- **Mechanical engineer:** WSP
- **Facade consultant:** ALT
- **Construction supervisor:** Yuanda International Engineering Management Consult Co., Ltd
- **Electrical contractor:** China Construction Industrial & Energy Engineering Group Co., Ltd
- **Fire consultant:** Arup

Structural system comprised fully braced mega-frame and central concrete core

TOM VAN DILLEN

IN BRIEF…

→| With a height of 528m, the CITIC tower in Beijing is the world's tallest building constructed in a high-seismic zone. It stands on a seven-story basement 40m deep.

→| The tower's smooth vertical curve provides structural stability at the base and accommodates more high-value floor area at the top levels. It has a gross floor area of 350 000m^2.

→| The structural system, comprising a fully braced mega-frame and central concrete core, provides robust and cost-effective seismic resistance. Extensive use was made of steel-concrete composite construction, such as composite steel-plate walls and composite mega-columns.

→| The cross-section of the mega-columns at their base is approx. 61m^2, while the 56 000m^3 of concrete required for the 6.5m thick base plate was poured non-stop over 93 hours.

→| Advanced design automation techniques, including parametric modelling and BIM integration, resulted in an architecturally consistent and construction-led design.

→| Parametric modelling allowed the engineers to study over 800 schemes to achieve a highly efficient structural solution.

CITIC Tower's smooth vertical curve provides more high-value floor area at top levels and structural stability at base

WENTAO

> **"THIS TALL TOWER PRESENTED MULTIPLE CHALLENGES TO ITS STRUCTURAL ENGINEERS**

JUDGES' COMMENTS

The judges were impressed with the multifaceted structural design for an extremely tall and slender building in a high-seismic zone.

Using parametric design, hundreds of potential solutions were explored. The tower employs a multiple lateral load-resisting system with a central concrete core and a perimeter mega-frame. The external mega-frame is built from concrete-filled steel box sections. Belt trusses at mechanical/refuge floors provide further stability.

An intelligent construction approach was developed using an integrated platform – a steel-framed structure set on the top of the concrete core that was jacked up as work progressed. This multilevel construction platform saved time and the cost of conventional cranes, and provided a workplace in the sky.

With its challenging form (widening towards the top), challenging location (high seismic conditions) and extreme height (528m), this tall tower presented multiple challenges to its structural engineers. They developed a design that combines well-known systems in an intelligent way, including an innovative means of construction.


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Award for Vehicle Bridges

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

Winner: Kienlesberg Bridge (Ulm, Germany)
Structural engineer: KREBS + KIEFER

P. BLAHA

> "THE SINUOUS SILHOUETTE IS DERIVED FROM THE NATURAL DISTRIBUTION OF BENDING MOMENTS

PROJECT TEAM

- **Client:** Stadtwerke Ulm: SWU Verkehr GmbH
- **Principal contractor:** SEH Engineering
- **Architect:** Knight Architects
- **Construction:** Geiger + Schüle Bau GmbH
- **Mounting and execution design:** Klähne Beratende Ingenieure

IN BRIEF…

The 270m long Kienlesberg Bridge is a combined tram, cyclist and pedestrian bridge spanning 14 tracks at a busy railway hub in Ulm, Germany.

The bridge was designed as a continuous steel beam, subdivided into five spans ranging from 34m to 75m.

The undulating appearance of the structure is a response to the flow of forces within the static system. The sinuous silhouette of the top beams and the distinctive pair of trusses crossing the longest 75m span are a homage to the nearby Neutor Bridge, a historic monument built in 1907.

The bridge crosses the portal of a high-speed railway project, which was being built simultaneously. Due to the heavily constrained site, launching proved to be an appropriate method of construction.

The structure of the main crossing was prefabricated in short segments, which were welded on site and then launched over live rail traffic.

↖ Kienlesberg Bridge spans busy railway hub in Ulm, Germany

↓ Undulating appearance of structure is response to flow of forces within static system

W. DECHAU

JUDGES' COMMENTS

This is a highly sympathetic new pedestrian, cyclist and tram bridge. The structure reflects the enormous benefits of interdisciplinary work between engineers and architects.

The sinuous silhouette is derived from the natural distribution of bending moments, and optimised for a longitudinal launching process.

At the same time, it is an architectural homage to the nearby 110-year-old wrought-iron Neutor Bridge. The judges admired how the graceful, economic and efficient appearance belies the complexity of the site and irregularity of the support conditions.

Notably, the structure of the main crossing was prefabricated in short segments, assembled on an elevated scaffolding at the south abutment and launched above the rail tracks.

This three-stage launch procedure was complicated by the curved east section, but well managed by the engineers.

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Award for Pedestrian Bridges

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

Winner: Tanxishan Glass Landscape Pedestrian Bridge (Zibo, Shandong Province, China)
Structural engineer: Tongji Architectural Design (Group) Co., Ltd

↑ Bridge is constructed from curved steel girder supported by single-sided cable arch

PROJECT TEAM

- **Client:** Zibo Tanxi Mountain Tourism Development Co., Ltd
- **Principal contractor:** Yangzhou Jiangan Color Steel Structure Engineering Co., Ltd
- **Architect:** Paradox Architecture Design Consulting (Beijing) Co., Ltd
- **Cable tensioning:** Shanghai Tonglei Civil Engineering Technology Co., Ltd

IN BRIEF…

→| The Tanxishan Glass Landscape Pedestrian Bridge spans between two cliffs in Tanxi Mountain Scenic Area, Shandong Province, China.

→| The bridge is constructed from a curved steel girder supported by a single-sided cable arch. The central axis of the arch is a parabola with a span of 109m and a height of 25m. The inclination between the arch and the girder is 60°.

→| The curved girder is made of a steel box section with a height of 1m. The central axis of the girder is an arc with a radius of 85m and a rise of 20m.

→| Due to the difficult terrain and narrow construction site, an innovative construction method was adopted, involving a two-stage superimposed rotation of the girder and arch.

→| Key hinge joints were designed to achieve the required capacity and serviceability, ensuring the safety and constructability of the bridge. Two sets of cable systems were arranged to balance the thrust during construction.

→| An advanced 3D laser technique was used to scan the complex terrain to a computer model for the base design and bridge positioning.

JUDGES' COMMENTS

This curved steel-girder deck, supported by a cable-stayed inclined arch, created a landmark for the area.

The bridge is flanked by dramatic mountainous terrain that challenged the team to design for complex topography in a remote site with narrow construction space.

Considerable attention to feasible and efficient construction led to an innovative two-stage rotation of the girder and arch during the construction sequence.

Efficiency in form was also considered by a load-balancing arch and deck, allowing for a single-sided cable solution.

The completed bridge is a sophisticated resolution of complex structural engineering considerations, realised in an elegant form.

Commendation: Taplow Footbridge (Taplow, UK)
Structural engineer: COWI

ANTHONY PREVOST

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Award for Long Span Structures

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

Winner: New Tottenham Hotspur Stadium (London, UK)
Structural engineer: BuroHappold Engineering and Schlaich Bergermann Partner

HUFTON+CROW

↑ New Tottenham Hotspur Stadium includes complex cable-net roof and long-span structures to accommodate retractable pitch

PROJECT TEAM

- **Client:** Tottenham Hotspur Football Club
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→| The stadium incorporates a retractable pitch, with 2090m of rails installed to allow the pitch to move in three sections. These take 25mins to fully slide beneath the south stand.

↓ Tree columns allow retractable pitch trays to slide beneath stand

GRESHOFF

→| The south stand contains 7217t of steel in three main spans, including feature 'tree columns' which allow the retractable pitch trays to slide beneath. Extensive transfer structures span the retracting pitch sections.

→| The club's desire for open spaces drove the use of post-tensioned (PT) concrete slabs, which resulted in 40% fewer concrete columns (approx. 1100 versus 1830).

→| 55 000m^3 of site-won aggregate was washed and used to produce 120 000m^3 of concrete for the lower-level structure, which saved an estimated 551 200 heavy-truck miles, equating to a CO_2 saving of 732 860kg.

→| BuroHappold provided all engineering disciplines on the project, including structural engineering for the primary building structures. The final detailing of the cable-net roof was by Schlaich Bergermann Partner.

JUDGES' COMMENTS

This is an impressive stadium containing many dramatic long-span solutions. The judges were impressed by the ingenuity shown by the structural designers in dealing with very challenging constraints and project requirements.

The roof is a complex lightweight cable-net structure with an external compression ring and two internal tension rings. Horizontal loads and uneven loading conditions are carried by geometrical stiffness only, thus optimising the primary structural members to a minimum size and achieving the desired lightness and transparency.

In addition to the roof, the concrete stands also incorporate long spans for various reasons, including the accommodation of the entire retractable pitch, which slides back under the south stand when the stadium is in use for concerts and other events.

The attention to detail throughout is exemplary and is an excellent showcase for the structural engineer's art.

Sponsored by ***The Structural Engineer***

Award for Small Projects of under £3 million

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

Winner: Millet Vinegar Museum (Zibo City, Shandong Province, China)
Structural engineer: Tianjin University Research Institute of Architectural Design & Urban Planning

↑ Optimised dome shape of Millet Vinegar Museum resists lateral forces

PROJECT TEAM

- **Client:** Shandong Huawang Brewing Co., Ltd
- **Principal contractor:** Shandong Luwang Decoration Co. Ltd
- **Architect:** Tianjin University Research Group of Architectural Design

“A PROJECT MADE BOTH CONCEPTUALLY AND AESTHETICALLY BEAUTIFUL BY AN ENGINEER’S SKILLED AND SYMPATHETIC GUIDING HAND

IN BRIEF...

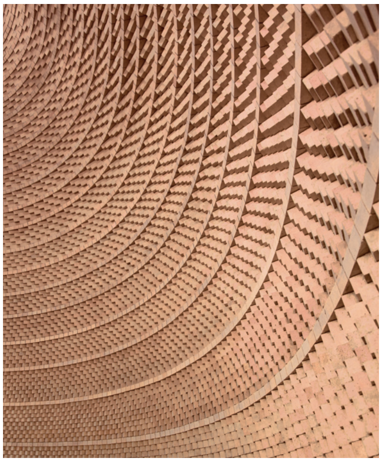
→| The entrance hall of the Millet Vinegar Museum is a newly built brick dome with a height of 9.1m and a diameter of 12m at the bottom. It was built of local refractory bricks to reflect the heritage of the area.

→| The shape of the dome was inspired by a vinegar jar, and sunlight shining through its skylight projects a shadow in the form of the vinegar jar into the room.

→| The main structure consists of 147 layers of bricks, with the number of bricks in each layer decreasing from 195 in the bottom layer to 51 in the top layer.

→| The stresses on the dome under static loading and bidirectional horizontal seismic forces were analysed using a finite-element model, with the shape of the dome optimised to minimise the tensile stress.

→| The team used the Grasshopper plug-in for Rhino to build an accurate construction model, and wrote a program to calculate the height, radius, number of bricks, angle of horizontal inclination and angle of rotation of each brick.



→ Angle of bricks changes with each layer to create decorative texture

JUDGES’ COMMENTS

The Millet Vinegar Museum’s beautiful brick dome stands 147 brick courses high and is punctured by three, large, arched openings.

While in some ways this may be seen as a traditional structure, the engineers’ approach to the design was evidently meticulous and bold.

The dome is in the highly seismic Shandong Province of China. The engineers were clearly resistant to the temptation to betray the pure brick form with steel or other ductile fixings. Instead, they relied on their confidence, borne of accurate and considered analysis and optimisation of the dome shape, to resist lateral forces.

Each layer of bricks was carefully planned and sequenced to avoid formwork. Subtle rotation of the various courses of bricks achieved the decorative texture of the arched openings. The result is a splendid example of a project made both conceptually and aesthetically beautiful by an engineer’s skilled and sympathetic guiding hand.

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: Tūranga (Christchurch, New Zealand)
Structural engineer: Lewis Bradford Consulting Engineers

ADAM MORK

↑ Tūranga was designed to be seismically resilient, ensuring building will be re-usable after serious seismic event

PROJECT TEAM

- **Client:** Christchurch City Council (Southbase Construction)
- **Principal contractor:** Southbase Construction
- **Architect:** Architectus and Schmidt Hammer Lassen
- **Structural peer reviewer:** Ruamoko Solutions
- **Specialist peer reviewer of hybrid walls:** Prof. Stefano Pampanin
- **Site-specific seismic hazard analysis:** Prof. Brendon Bradley
- **HF2V damper design:** Prof. Geoffrey Rodgers
- **Geotechnical engineer:** Tonkin + Taylor

IN BRIEF…

→| Tūranga is the new central library built for Christchurch City Council as a key anchor project following the devastating 2010–11 earthquakes in the city.

→| The building was constructed to very stringent seismic performance criteria, and is designed to sustain minimal and readily repairable structural damage during a large earthquake.

→| An integrated, self-centring mechanism allows the building to sway and then return to its original position while dissipating seismic energy using state-of-the-art replaceable devices.

→| Part of the innovative design is a seismic force-resisting system made up of large-scale precast concrete walls that can rock, isolating the building from peak earthquake accelerations during a significant event.

→| The building construction employed five-storey 'tilt-up' precast concrete panels weighing 150t – some of the largest ever attempted in the southern hemisphere. These resulted in a self-stable building for the majority of the construction phase.

JUDGES' COMMENTS

The concept for this five-storey, 10 000m² library was inspired by the 2010–11 earthquakes that affected Christchurch, New Zealand, where the majority of buildings remained safe, but a great number were uneconomic to repair and required demolition.

Tūranga's hidden beauty lies in its level of seismic resilience, such that after a serious seismic event, the shock-absorbing systems could be readily replaced and the building would be re-usable.

The massive concrete core walls, some weighing around 150t, were cast flat on site and then 'tilted up'. They provide stability to the building and, in a seismic event, are able to 'rock' due to their connection to the foundations and to adjacent components being made with replaceable shock-absorbing devices. They work in conjunction with a perimeter steel moment-resisting frame which also has rocking base connections.

The engineers were instrumental in encouraging plant, which would have been positioned in a basement, to be placed on the roof, allowing the proposed basement to be removed from the scheme. This enabled the building to be constructed off a shallow gravel layer, avoiding both the expensive basement and costly piled foundations.

A great example of how structural engineers can make such a crucial difference to a building, this is – in every sense – a building that rocks!

Commendation: Claridge's Basement (London, UK)
Structural engineer: Arup, McGee Group, RKD Consultant

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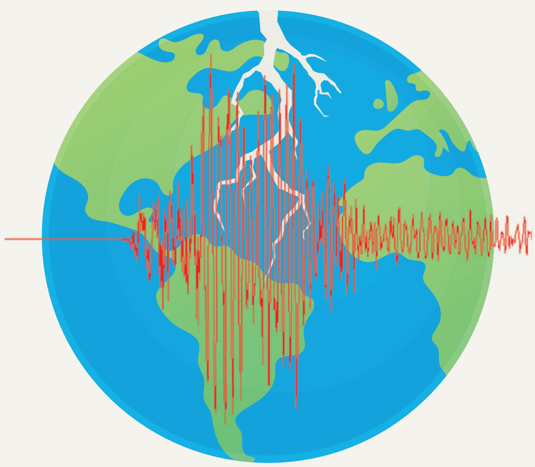

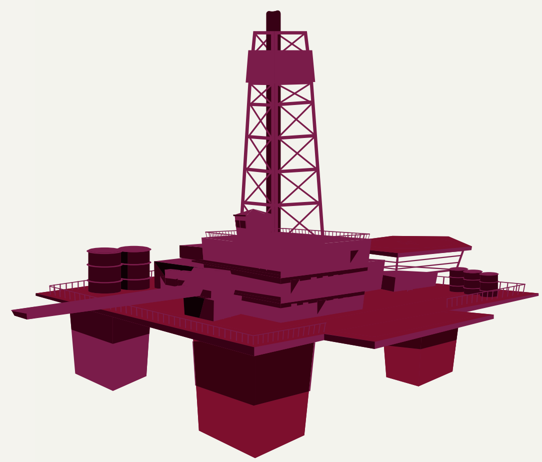

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Award for Structural Heritage

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

Winner: Newquay Harper Footbridge (Towan Beach, Newquay, UK)
Structural engineer: Free4m Consulting

↘ Restored Newquay Harper Footbridge is one of few 'Harper Bridge' designs remaining in UK

FREE4M

PROJECT TEAM

- **Client:** Caspar and Jo Lawson
- **Principal contractor:** DuPrey Rigging and Metal Fabrication
- **Architect:** Free4m Consulting
- **Harper Bridge specialist:** Douglas Harper

IN BRIEF…

→| The Newquay Harper Footbridge is a light suspension bridge originally constructed in 1901 by the innovative British engineering company, Harper.

→| John Harper was a pioneering engineer and one of the first to employ steel wire rope in suspension bridges, which is now universally used.

→| The footbridge is one of few 'Harper Bridge' designs remaining in the UK and connects the mainland with a private house on The Island, a small outcrop on Towan Beach.

→| Free4m was commissioned to restore the footbridge after earlier remedial works – in which poorly detailed stainless steel hangers and clamps were added to the original mild steel structure – had begun to corrode the main catenary around the hangers.

→| The team engaged Douglas Harper, a descendent of the Harper family, and together they returned the bridge to its original structural design, saving this small but important piece of British engineering history.

→| Free4m devised a method to carry out restoration works without support works, allowing the bridge to remain open throughout and creating a considerable cost saving for the client.

> "THE JUDGES WERE IMPRESSED BY THE MINIMALIST APPROACH

JUDGES' COMMENTS

The structural engineers carried out considerable research into the history of the bridge and even consulted with the original designer's grandson, who has himself researched the history of Harper bridges.

The scheme recognised that only the suspension bridge hangers were in need of replacement and researched the original details, thus returning it as close as was feasible to its original design.

In this way, the suspension cables were saved, which resulted not only in a highly sustainable solution but saved significant cost and areas of the original structure.

The judges were particularly impressed by this minimalist approach, which was underpinned by detailed research and sound engineering judgement.

Commendation: Century Project: Space Needle Renovation (Seattle, WA, USA)
Structural engineer: Arup

NIC LEHOUX

Sponsored by **Energi People**

Award for Structural Transformation

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

Winner: Coal Drops Yard (King's Cross, London, UK)
Structural engineer: Arup

JOHN STURROCK / ARGENT

↑ Coal Drops Yard features elegant 'kissing' roof with dramatic suspended floor

PROJECT TEAM

- **Client:** Argent
- **Principal contractor:** BAM Construction
- **Architect:** Heatherwick Studio
- **Services engineer:** Hoare Lea
- **Delivery architect and services engineer:** BAM Design
- **Steelwork subcontractor:** Severfield
- **Project manager:** Gardiner & Theobald

IN BRIEF…

→| Coal Drops Yard is a unique retail destination within the King's Cross development in central London. The development includes a new shopping street with cafes, restaurants, event space and public realm.

→| The project is an ambitious and ingenious repurposing of Britain's industrial heritage, combining Victorian engineering with contemporary interventions that enhance the drama of the historic architecture.

→| It features a broad range of modern and historic structural materials: cast iron, steel, masonry, concrete, timber and glass.

→| The project's most striking feature is a new roof with a floating floor suspended from it by hangers, but it also required the sensitive and forensic assessment of the existing buildings; the design of an elegant folded-plate glazing system; and the addition of three new bridges across the yard.

→| The roof has primary steel rafters spanning directly between the buildings, connecting at the apex and tied across at their base to form an A-frame. However, the roof geometry at the apex prevents the primary rafters from 'noding' out.

→| The solution was to insert a V component (the 'kissing point') which acts in bending to transfer forces across the apex while keeping the structure within the cladding envelope.

↘ Historic structure was restored wherever possible

JOHN STURROCK / ARGENT

JUDGES' COMMENTS

This transformation project required intricate structural design solutions to ensure faithful delivery of the fine architectural aesthetics.

Restoration and renovation of the existing brick, timber and cast-iron structures was carried out after individual assessment of their structural viability, retaining as much of the original materials as possible.

The success of the development relied upon the creation of a suspended floor linking the East and West Coal Drop buildings, thereby creating a unified public area protected by the peeled-back slate roofs complemented by infill glazing to the lenses created by the new roof geometry.

This was achieved through an elegant roof structure consisting of a primary tied arch at the centre of the new deformed roof plates, which in turn supports secondary trusses following the curved geometry of the roofs and from which the new floor is suspended.

The primary truss has a moment-resisting V-notch at its apex to faithfully maintain the aesthetic of the 'kissing' roofs. Torsion and deflection of the curved trusses were carefully calculated and systematically monitored throughout the construction process to maintain deformation of the suspended floor within predetermined acceptable limits.

The design team has skilfully combined sensitive renovation of neglected heritage structures with complex extensions to form a seamless and integrated composition.

Sponsored by **Beale & Co**

Award for Construction Innovation

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

Winner: Morpheus Hotel (Macau, China)
Structural engineer: BuroHappold Engineering

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↑ Morpheus Hotel's structural exoskeletal frame gives building striking appearance

PROJECT TEAM

- ➔ **Client:** Melco Resorts
- ➔ **Principal contractor:** Dragages Hong Kong
- ➔ **Architect:** Zaha Hadid Architects
- ➔ **Facade contractor:** Kyotec Group
- ➔ **Temporary works engineer:** Tony Gee
- ➔ **Steelwork fabricator:** FDL GSI

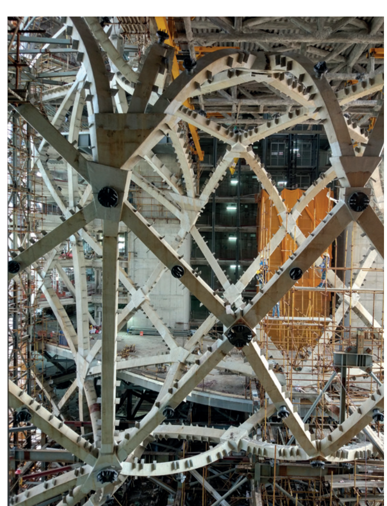
IN BRIEF…

→| Standing 160m high, Morpheus is the fifth tower in Macau's 'City of Dreams' complex, a premier leisure and entertainment destination for national and international visitors.

→| The 150 000m^2 hotel will accommodate 780 guest rooms, luxury suites and villas, retail outlets, restaurants, a casino, spa and sky pool, as well as meeting and events spaces. Accommodation is arranged around a core in each wing of the building.

→| The building form was sculpted and optimised around buildability, structural performance and the rationalisation of the glazed facade.

→| The steel exoskeleton morphs from being the support of the floor plate in the hotel areas to a free-form structure that defines the enclosure of the central parts of the building.



➔ Over 2500 steel connections were analysed using parametric workflow to resolve geometrical differences between members

→| For the exoskeleton, a geometrical solution was developed that avoided warped structural members in the doubly curved central area by using members with single curvature in one plane only. The geometrical difference between members meeting at a node, and the notional twist, was resolved in the connection detail.

→| Over 2500 connections – divided into over 350 unique types – underwent finite-element analysis using stand-alone ROBOT models, with forces/moments from all 105 load cases in the global MIDAS model mapped onto them. The process was run using Grasshopper parametric software, which integrated MIDAS, ROBOT, Rhino3D and Excel.

JUDGES' COMMENTS

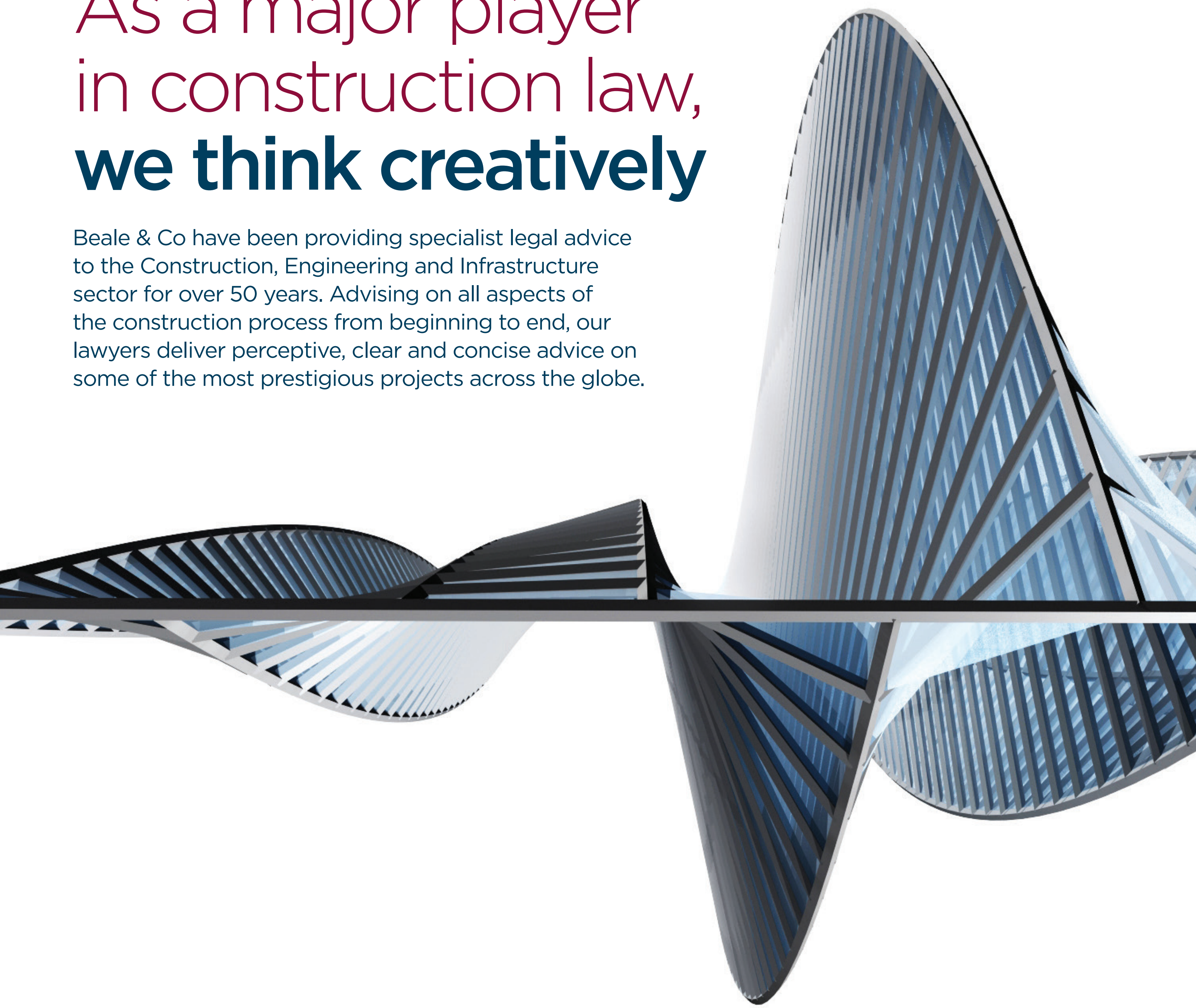
The Morpheus Hotel was envisaged from the outset to be an iconic building. Though not overly tall, the external appearance is particularly striking, due principally to the building's structural exoskeletal frame and the visual effect of the three irregular openings that penetrate the main rectangular form from north to south.

The structural engineering involved is impressive, and was considered by the client body at concept stage to represent a 'step into the unknown'.

The building excellently demonstrates the transition and broadening of the expertise of the structural engineer that has steadily been taking place in recent years to encompass a range of high-end digital skills, including the bespoke code-writing capabilities needed to enable different structural design and analysis software packages to communicate interactively with each other.

This allowed the proposed structure to be tested rigorously against 105 different possible load combinations, to generate the confidence needed for that next unknown step to be taken.

The Morpheus Hotel could not have been delivered without these highly specialised skills.



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: Qingdao World Expo City (Qingdao, Shandong Province, China)
Structural engineer: China Architecture Design & Research Group

PROJECT TEAM

- **Client:** Qingdao Cosmopolitan Exposition International Conference and Exhibition Co., Ltd
- **Principal contractor:** China Railway Tianfeng Construction Engineering Co., Ltd
- **Architect:** China Architecture Design & Research Group
- **Steel fabricator:** China Railway Heavy Machinery Co., Ltd
- **Supervision:** China Railway Huatie Supervision Co., Ltd
- **Curtain wall fabricator:** Shenzhen Qixin Construction Group Co., Ltd

IN BRIEF…

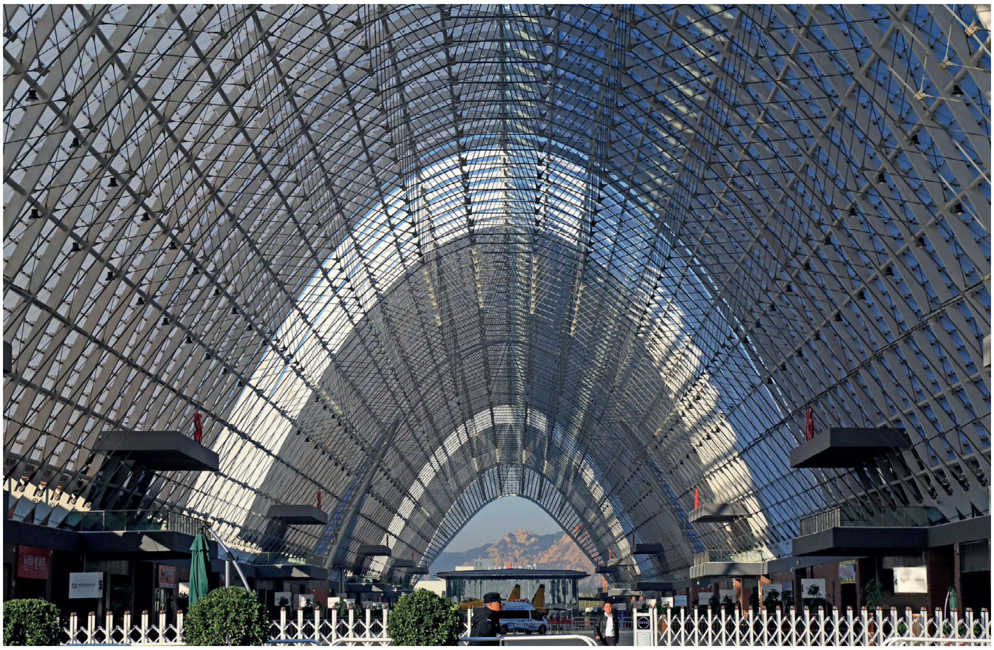
→| The Qingdao World Expo City project is a cross-shaped exhibition gallery running 507m in the east–west direction and 287m in the north–south direction.
→| The gallery is open to all sides and connects 12 independent exhibition halls around the site.
→| Innovative ideas implemented in the project include a prestressed cable-arch structural system with triangular flexible ties at the middle and rigid struts near the supports, polycarbonate plates on the roof, and various optimised connections.
→| The arches along the east–west direction form the primary structure, with a span of 47.5m and a height of 28.8m.
→| The prestressed cable-arch structure saved about half the tonnage of steel that would have been required with a traditional arch structural system.

JUDGES' COMMENTS

Arranged in a cruciform plan with a 500m long, 47m high primary gallery intersected by a 300m long, 32m high cross gallery, the structure creates a magnificent light-filled circulation area between large exhibition halls.

The height of the primary gallery is dictated by the surrounding buildings and, being in a coastal area, it experiences high wind loading.

To maintain the lightest of structures, a novel prestressed cable arch was developed, with a fabricated box section of just 500mm depth to 48m span.


GUANGYUAN ZHANG

↑ Exhibition gallery employs prestressed cable-arch structural system with triangular flexible ties

> CAST STEEL COMPONENTS HAVE BEEN SKILFULLY PARED DOWN

It is estimated that the use of the cables has permitted a steel weight saving of up to half compared to a traditional arch structure.

Cast steel components, from cable clamps to arch base pins, have been skilfully pared down for the most compact of connections and have enabled quick and safe construction on site.

The judges particularly admired the simple elegance at the intersection of the crossing galleries and the visual coherency of the structure.

Commendation: Velvet Mill (Bradford, UK)
Structural engineer: Price & Myers


JOEL CHESTER FILDES / URBAN SPLASH

Sponsored by **Oasys**

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.

TIMOTHY SCHENCK

← Vessel was designed as lattice of ramps and landings

Winner: Vessel (Hudson Yards, New York, USA)
Structural engineer: AKT II

PROJECT TEAM

- **Client:** Related Companies
- **Engineer of record:** Thornton Tomasetti
- **Principal contractor:** Cimolai
- **Architect:** Heatherwick Studio

IN BRIEF…

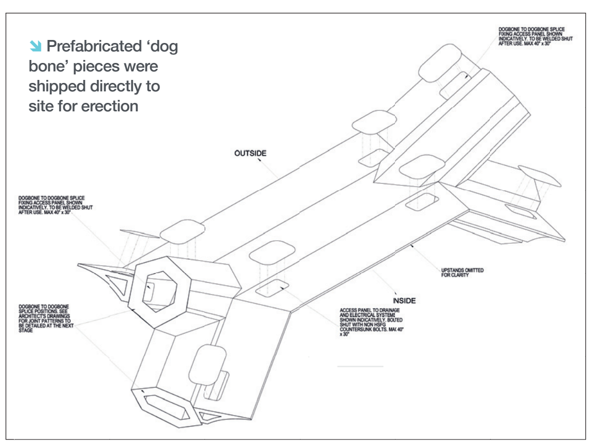
→| Vessel is a ground-breaking interactive sculpture which creates an innovative new centrepiece for the Hudson Yards redevelopment in New York.

→| The sculpture takes inspiration from the appearance of an Indian stepwell, inverted into a structure that reaches skyward, to form a bowl or 'vessel' shape.

→| Designed as a lattice of ramps and landings, forming a rigid, monolithic structure, Vessel is characterised by inner and outer layers of stair ramps. In all, the vertical, zigzagging pattern includes 80 landings and 154 flights of stairs, comprising almost 2500 individual steps made from 75 steel pieces coated in cupronickel.

→| The 600t structure was prefabricated in Italy, with the 'dog bone' pieces shipped directly into Hudson Yards, where they were lifted by crane and bolted together.

→| Standing 46m tall and 46m in diameter, with a footprint just 15m wide, Vessel has a capacity of 1500 people. This was determined by the dynamic behaviour of the structure, with structural vibrations required to be kept at an acceptable level.



↘ Prefabricated 'dog bone' pieces were shipped directly to site for erection

JUDGES' COMMENTS

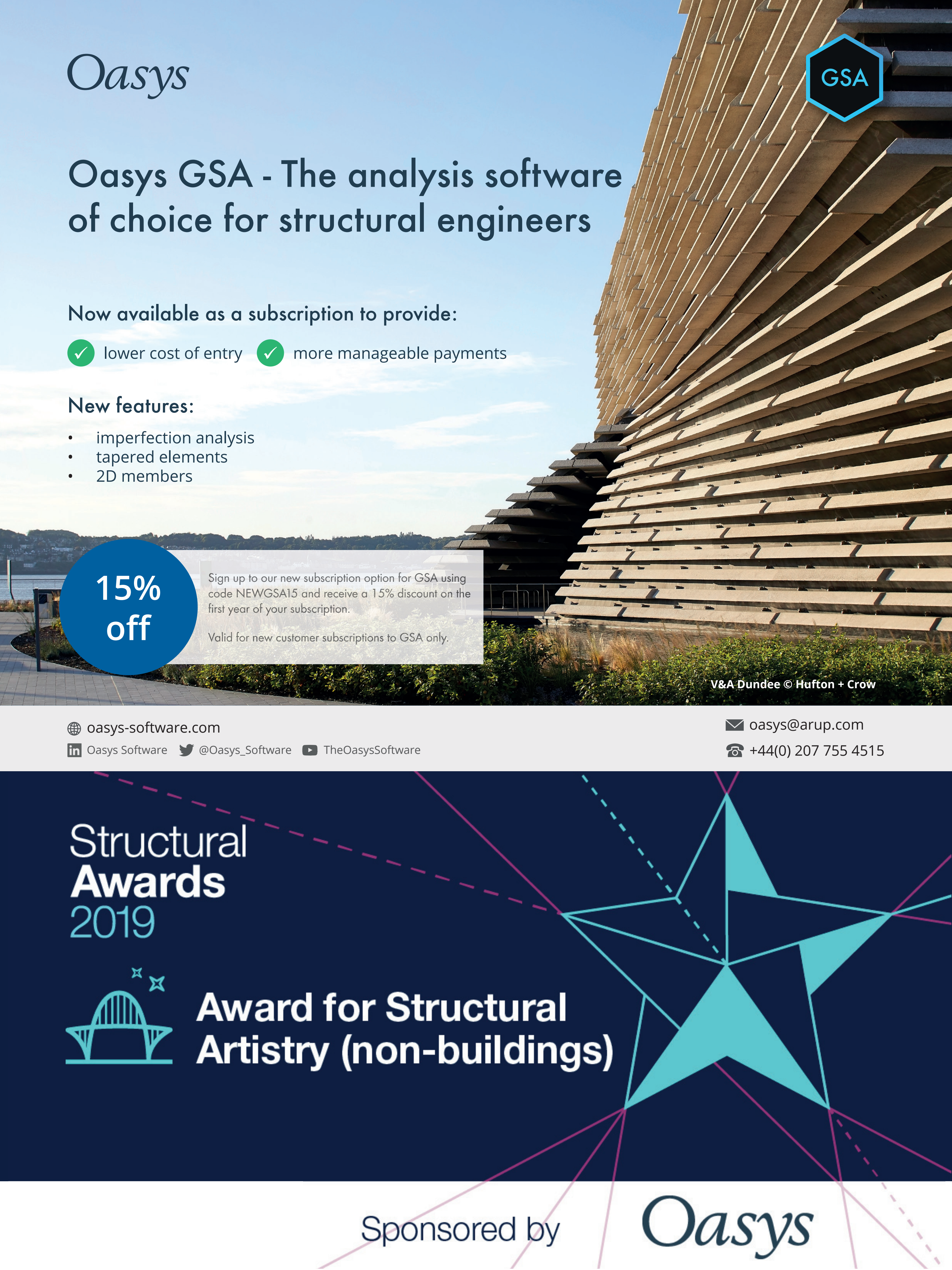
The structural engineering challenges that were met to deliver this piece of urban inhabitable sculpture ranged through analysis, design and construction.

But for each of these, the uniqueness of the structure meant the challenges themselves were also unique.

The structure is the architecture and vice versa. With the form comparable to a massive spring, addressing vibration was more complex than in other structures. This challenge was met with impressive engineering analysis and design.

> "THE UNIQUENESS OF THE STRUCTURE MEANT THE CHALLENGES WERE ALSO UNIQUE

Commendation: Gate of Chongqing Longhu Park (Chongqing, China)
Structural engineer: XinY & Co-base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Structural Awards 2019
Award for Structural Artistry (non-buildings)
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Award for Sustainability

For projects demonstrating outstanding commitment to social, economic and environmental impact in the structural design – selected by the judges from all the entries.

Winner: La Référence (Ganthier, Haiti)
Structural engineer: Eckersley O'Callaghan

↑ School was constructed from local materials to seismically resistant design

PROJECT TEAM

- → **Client:** Konekte
- → **Principal contractor:** JSC Construction
- → **Architect:** Studio PHH Architects

IN BRIEF…

→| This was a charitable engineering project to support the construction of a new secondary school in Haiti, providing four classrooms, a library and computer lab to serve 150 students.

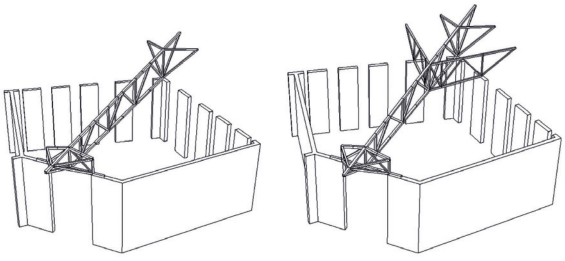
→| Situated in a highly seismic zone and an area prone to hurricanes, the school's resilience was of paramount importance.

→| The design used local concrete masonry units, with ductility achieved through strategic grouting and reinforcing of the wall elements, allowing energy to be dissipated in an earthquake.

→| Rationalisation of the roof framing, which comprises built-up trusses, purlins, rafters and decking, was a significant challenge. Each truss and member was clearly detailed to allow for construction directly from the design drawings, and a series of stepwise diagrams walked the contractor through each phase of installation.

→| The project was constructed in only nine months – a very difficult achievement in Haiti.

↓ Step-by-step diagrams guided contractor through roof installation



> “THIS SCHOOL PROJECT PULLS TOGETHER NUMEROUS POTENTIAL STRUCTURAL ENGINEERING ASPECTS OF SUSTAINABLE DESIGN

JUDGES' COMMENTS

This pro-bono-designed school project in Haiti pulls together numerous potential structural engineering aspects of sustainable design.

Following the recent devastation caused by earthquakes and hurricanes, pragmatic solutions have been required in order to rebuild.

This school project not only exemplifies a resistant structural solution, but it does so in close collaboration with local engineers and construction teams.

All documentation and processes were methodically designed to develop local understanding of structural behaviour and become educational tools for replication, ensuring a social legacy within and beyond this specific project.

Design decisions incorporated local materials and skill availability with the challenging design loads and respective detailing.

Limited resources required creative design approaches and innovative solutions to develop ductile connections resistant to earthquakes with minimal additional material from traditional seismic construction.

All this was achieved while coordinating with other disciplines for natural ventilation, daylighting and acoustic performance, ultimately providing a nourishing educational atmosphere.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