Castle Green Bridge

Summary of Lighting Concept

The lighting concept for this bridge is an intrinsic part of the overall conceptual approach to the design.

The bridge is a key component of the Taunton Cultural Quarter Masterplan. This project streamlines the pedestrian routes from the Green and through the adjacent Goodland Gardens, by doing so increasing legibility of the site for pedestrians, improving the quality of public space, and linking the castle and river with nearby retail and redevelopment. The bridge spans a Scheduled Ancient Monument and is bounded by Taunton Castle, a Grade 1 Listed building.

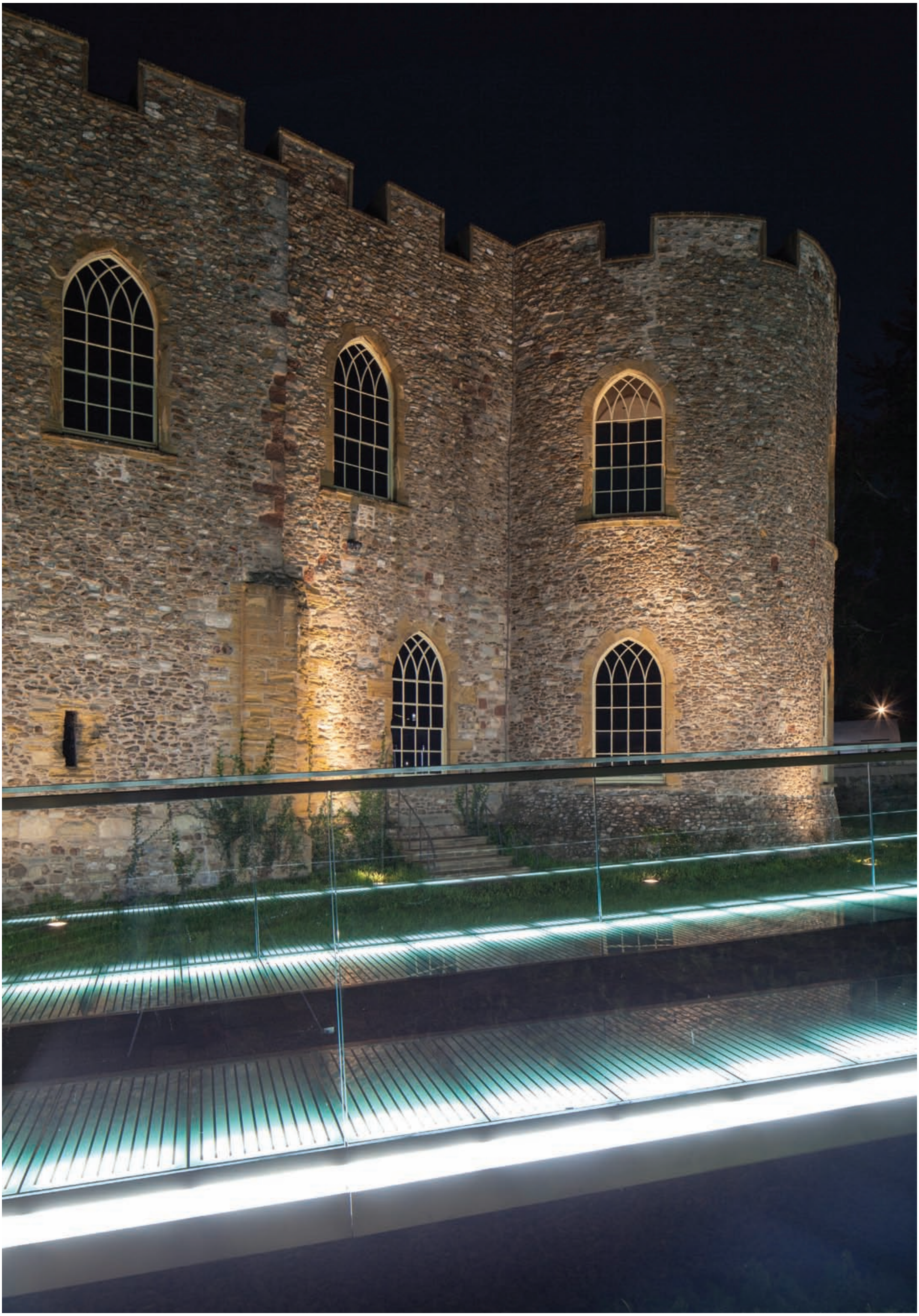
Given the sensitive location the principle approach adopted in the design is one of reticence; the curve of the bridge yields to the main tower of the Castle while the deck taper sets up a subtle false perspective – apparently prolonging the walk to the town square while shortening the journey towards the Gardens. The lighting design is critical in maintaining this posture of subtlety and elegance – the lighting must perform a functional role in providing way marking while also complementing the historic context. As such and in contrast to the norm the lighting design played a very large part in determining the form of the bridge.

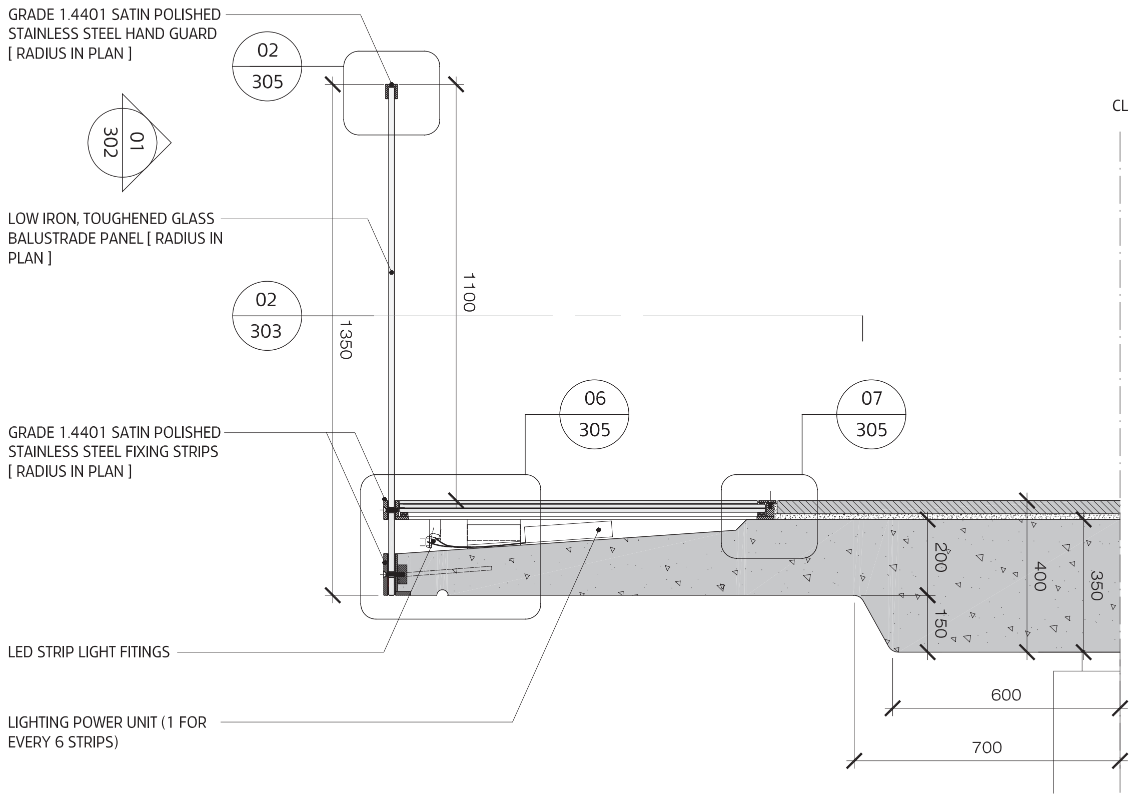
The Lighting Design

The cross sectional form of the bridge was developed specifically with the lighting design in mind.
The design is developed from a cross sectional principle whereby a flat soffit is combined with a shallow inverted 'V' to describe a concrete structure with a very narrow edge profile. This in turn carries the deck surfacing of stone and glazing, with glass parapets contained within a protective band of steel on all exposed edges. The sides of the bridge are formed by glass on the deck surface and on the lower portion of the parapet edge – creating a translucent 'volume' of glass specifically to contain the bridge lighting system.

While the glass 'volume' helps to lessen the visual mass of the bridge during the day it is at night that its functional purpose becomes apparent. Continual longitudinal runs of low power LED lights illuminate the volume, at a stroke fulfilling both the functional lighting requirement and providing the night time identity to the structure. The laminated glass deck and edge panels contain translucent interlayers that diffuse the light and give the appearance of solid 'blocks' of light running along the deck edges.

The Surelight 'Orion' LED fittings selected are paired - to shine upwards through the walking surface and outwards through the deck edge - and run in discrete sections of approximately 450mm in length. Lighting power units are installed for every six strips [three bays] with the control panel for the system being centrally located off the bridge alongside the lighting control for the whole public realm in the area, which is primarily triggered by a daylight sensor but features a manual override. Maintenance of the fittings is achieved through the removal of a series of tamperproof fixings and the careful lifting of deck panels.





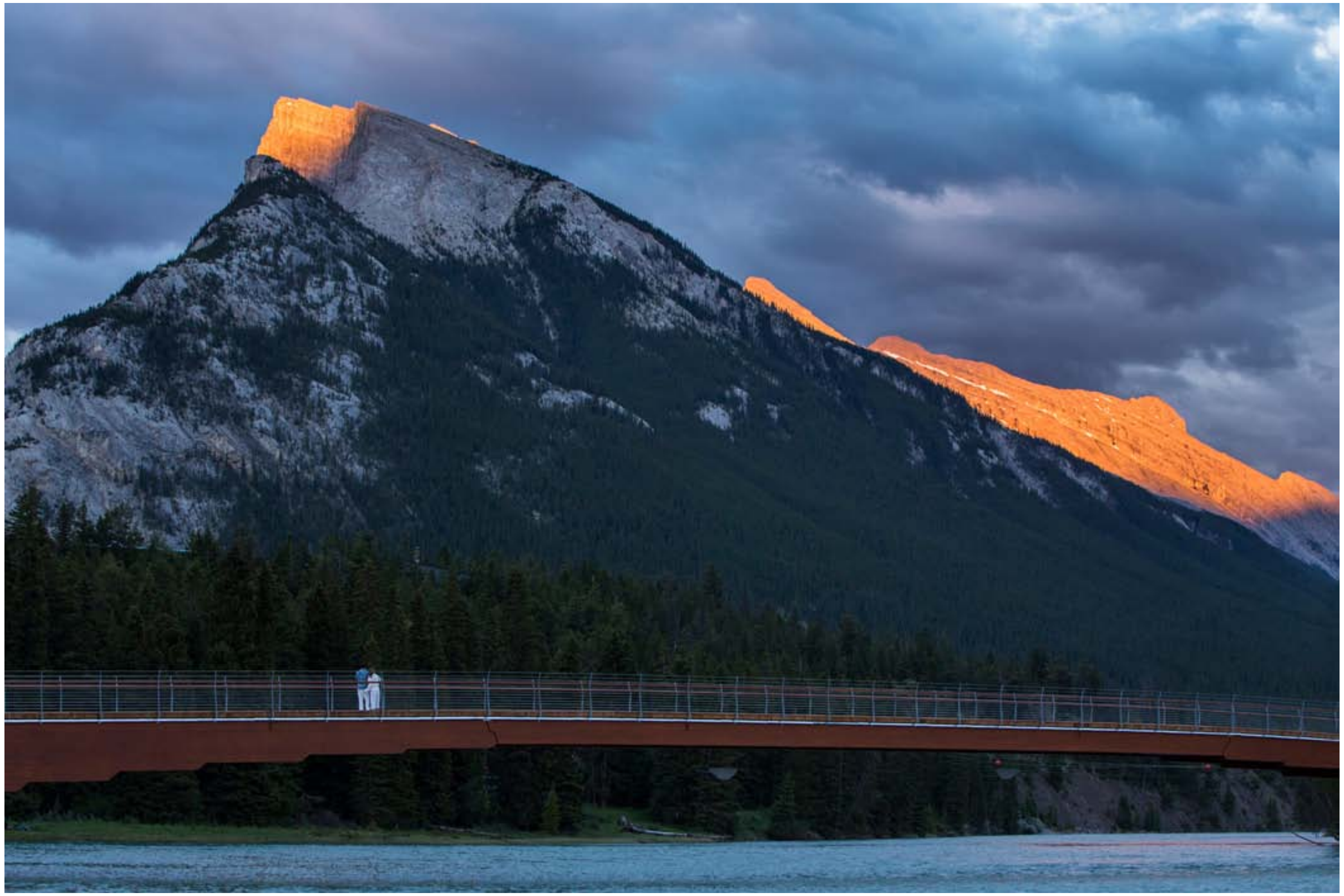
04 SECTION DETAIL - BRIDGE

SCALE 1:10 @ A1

Footbridge over the Bow

Banff, AB, Canada

The historical Town of Banff, set in the beautiful Canadian Rockies, is one of the most visited tourist destinations in North America. The town sought a new crossing which would not only be functional, but would also enhance the stunning mountain and river setting. It is an important community link, encouraging walking, jogging, and cycling. The material choices are in keeping with those of the community, including timber as primary structure, stone, and well-detailed galvanized steel. Driving the agenda, however, was the more pressing concern that existing sanitary pipes installed below the river at this location some fifty years earlier could fail, spilling raw sewage into the pristine Bow River. So the bridge now needed to carry the new pipes as well as provide a secondary access for emergency vehicles. The project also had to meet stringent environmental requirements of Canada's oldest national park. The design features an 80m clear span, which for a timber bridge is one of the longest of its kind in the world. This, with an extremely slender curved profile, creates the primary design challenge for the bridge: its dynamic behaviour due to pedestrian excitation.



Design

The primary structural system is simple: Propped by drilled piers located just outside the normal river channel, 40m haunched glulam girders cantilever from either side to support a 34m suspended span.

The bridge cross section comprises twinned sets of glulam girders stepped to follow the flow of forces, which range in depth from 2.6m at the piers to 0.9m at the suspended span.

The 4m wide deck is made of pre-stressed solid timber panels, removable to provide access to the service pipes hidden below.

The concrete abutments at either end of the crossing tie down the haunch ends, but also house the pump station, eliminating the need for any additional above-grade structures.

The horizontal steel trussing provides both the diaphragm and support for the service pipes just below the bridge deck. It is configured such that only the timber is continuous, resulting in very little length expansion.

The central drop span sits on neoprene bearing pads on notches in the receiving ends of the cantilevered glulam girders. This detail is achieved by using long screws which invisibly reinforce the notch, forming an elegant connection which left plenty of tolerance during erection.

A visually minimal stainless cable guardrail system involving 135m long continuous cables, required fine-tuned pretension analysis to ensure adequate tension in the summer, and avoid overtension in the winter.

Durability

Durability was a topic of significant interest to the client, and great care was taken in detailing to ensure a 75 year design life.

Spacing between the paired glulams allows full ventilation, and the shingled heavy gauge flashing creates a strong drip edge protecting the beam faces.

All steel components are hot dip galvanized or stainless steel, and rubber spacers or grommets separate the two where they interface.

The guardrail system is anchored through the flashing to the beams in a unique way so that there are no penetrations.

Glulams are coated with a system which behaves like a breathable membrane and is easily re-coated.

Structural and Vibration Analysis

While the primary behaviour is simple, the internal behaviour of the stepped beams is not, requiring finite element modeling, and special grading and selection of the beam laminations. The long span and slender profile of the bridge, while enhancing aesthetics and minimizing material (and, critically, erection weights), make it susceptible to both vertical and lateral excitation from human traffic on the bridge. Fundamental vertical frequencies are 1.5 Hz. (walking) and 3.3 Hz (jogging).

Through much research and testing, two cable-suspended masses were visually exposed (for honesty) as unique tuned-mass dampers to address footstep and jogging excitation respectively. Response reduction was verified through field-testing of actual frequencies and accelerations.

Fabrication and Erection

A parametric 3D model of the entire bridge was created early, allowing rapid investigation of a multitude of design decisions, providing visual feedback to both designer and client.
A tight site and harsh winter, coupled with a desire to complete the lifts before spring thaw, made ease and accuracy of assembly in the field critical. The main structural elements of the bridge were too large to be transported to the site; and fitting up the pieces over the river with a smaller crane would have presented significant environmental and safety challenges. Thus individual elements were prefabricated in the shop and shipped to site as a kit of parts. All cutting, drilling, sanding and finishing was performed indoors under controlled conditions so that members are permanently protected. Jigs were built to ensure accurate assembly of the main bridge components on the riverbanks. In all, the entire bridge superstructure was erected in 3 lifts over 2 days, with the heaviest assemblies weighing in at over 50 Tonnes.

JARROLD BRIDGE, RIVER WENSUM, NORWICH

A Unique Double Propped Cantilever Pedestrian Bridge

'Jarrold Bridge' is the latest in a long tradition of bridges and fulfils the 20 year old dream of Peter Jarrold, our client, and former chairman of the Jarrold business. Upon completion Peter commented:

"This bridge is a glorious addition to the many Norwich bridges constructed over the years. It is a sophisticated construction in wood and rusted steel with a very pleasing form...... I think it is quite fantastic"

APPEARANCE, HARMONY WITH THE ENVIRONMENT

The essence of the concept was for a bridge that touched the ground lightly and traced a smooth, uninterrupted arc over the water.

The structure responds to its riverside environment, where the banks have a softer edge, and the surrounding paths and green space a more human scale, than the urban stretches up and downstream. Just over 80m in length, the bridge's sweeping curves are derived from the unique features of the site itself and the clearances imposed on the structure.

The two best landing points were determined at an early stage, and the smooth curvilinear 3D geometry developed to follow the optimal path between these points that accommodated all required clearances, without ever being steeper than 1 in 20.

Fixed by concrete abutments at each end and propped by two slender pin-jointed stainless steel columns, the bridge acts as two mutually stabilising, propped cantilevers with a central span over the river of approx. 40m.

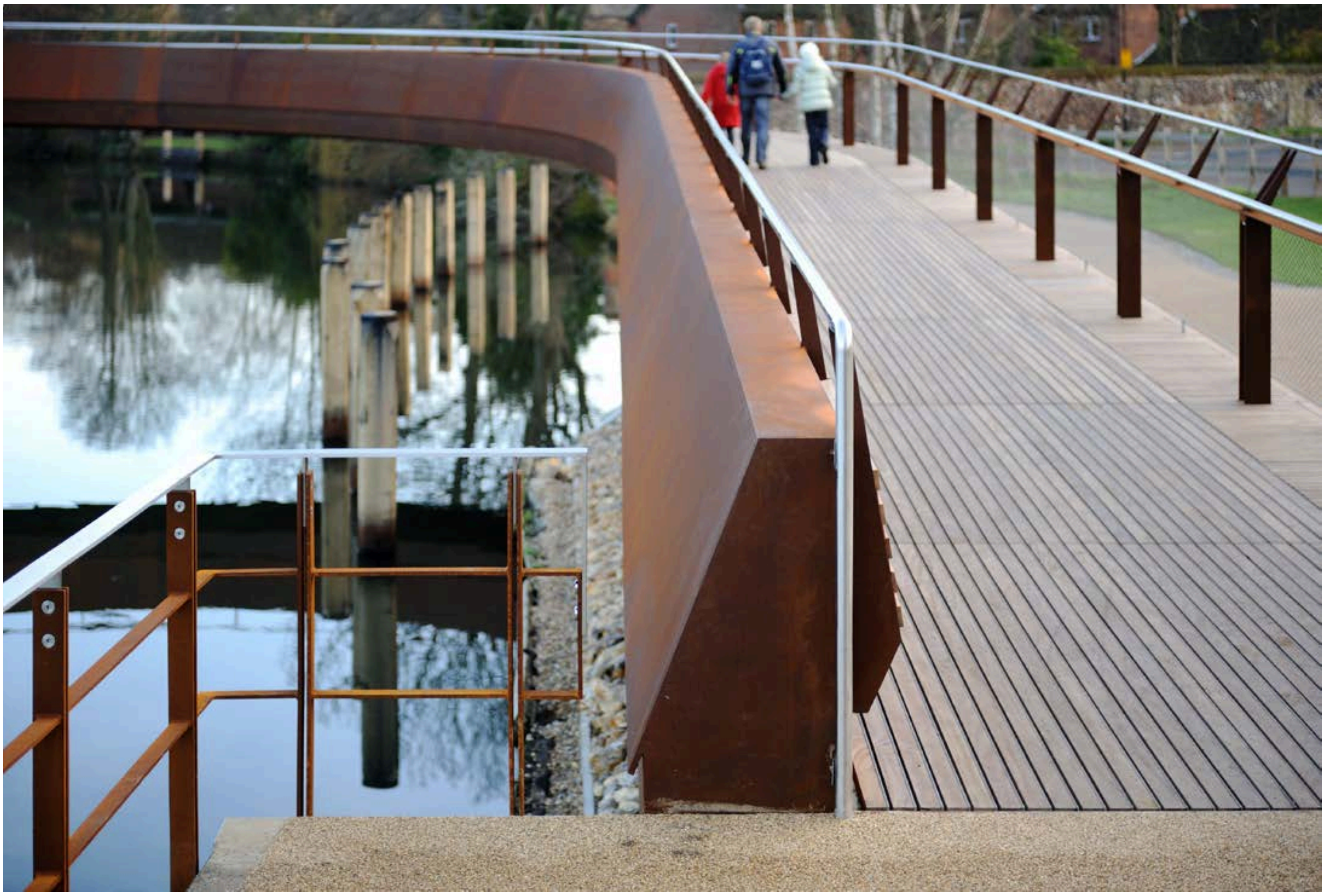
INNOVATION AND QUALITY OF DESIGN

A trapezoidal steel box girder forms the spine of the bridge, with all loads from the deck and balustrade transferred via cross-beams which cantilever from the spine. This applies torsion and bending to the girder, the torsion in one arm of the bridge being resisted by the bending capacity of the other.

At each abutment a fixed uplift bearing, below the box girder, and a sliding guided bearing, under the outer end of each bearing beam, provide vertical, lateral and torsional restraint.

The bridge thus resists horizontal loading by acting as an arch in plan, supported by cross-bracing which ties the structure together. Thermal expansion is realised as bending in the corresponding perpendicular 'arm' with pin-jointed columns providing vertical support whilst allowing rotation and lateral movement as the beam flexes.

The primary beam incorporates a simple detail where adjacent weathering steel plates over-sail one another. This creates a cleaner, sharper profile, breaks up the mass of the beam and conceals the welds at junctions. It also has the practical benefit of creating a continuous drip detail that avoids uneven staining.



EFFICIENT USE OF MATERIALS

Just three complementary hard-wearing materials were utilised throughout:

- The main structure is fabricated from weathering steel. Chosen both for its aesthetic and its long term maintenance benefits, it should require no maintenance over its lifetime of 120 years.
- The deck surface is Cumaru, an untreated renewable hardwood specified for its density, strength and durability. A unique hidden clamp system fixes the strips invisibly to bearers, bolted to the steel structure. Inset carborundum strips ensure slip-resistance in all weather.
- Stainless steel top rails accommodate long-life LED strip lighting and a lightweight stainless steel mesh encloses the deck, allowing full visibility along the river.

SUSTAINABILITY AND LIFECYCLE COSTS

This combination of materials is designed to weather and improve with age. With no applied finishes anywhere on the bridge, maintenance requirements and lifetime costs are reduced to a minimum.

An emphasis on off-site manufacture delivered significant benefits:

- Site welds were minimised to control welding and dimensional requirements in workshop conditions.
- Bridge component size and weight were controlled to minimize transport and lifting operations.
- Environmental impact was reduced through limiting the number of deliveries to site and significantly reducing site works and their potential impact on the public and wildlife.
- A bolted splice connection was developed mid-span removing any need for temporary works in the river during installation.
- Successful installation of the whole bridge was completed in a matter of hours over two days in November 2011.

Successful installation of the whole bridge was completed in a matter of hours over two days in November 2011.

VALUE FOR MONEY

The bridge was delivered on time and on budget.

Despite the focus on quality of materials and finishes, benchmarking against similar landmark bridges confirmed the final cost, at under £4K/sq m, represents excellent value for money.

BENEFIT TO THE COMMUNITY

Jarrold Bridge is primarily a pedestrian link, secondly a cycle way, but also a meeting place in its own right. The form of the bridge encourages people to linger and take in views of the Cathedral, the river and the surrounding areas. Response to the bridge has been overwhelmingly positive; with the following quote from a local office worker, typical of many received:

"I use the bridge every day when cycling into work. It actually gives me a 'happy boost' every morning as I cycle across. The design is amazing with the distinctive architectural sweeping curve. The mystery of how it holds up without seeming to have any support makes me smile every time. I love the combination of wood and rusted metal creating such a strong and unique artistic design. When I leave work in the evening I am often stopped in my tracks looking across the sweep of the bridge, framing the Cathedral to a backdrop of Norfolk's famously heart-lifting 'big sky' sunsets. I never expected to have an emotional response to a bridge, but the Bridge does exactly this."

Jarrold Bridge is a dynamic and unique bridge form that appears to float over the site with little visible means of support.

MEDIA CITY FOOTBRIDGE

FOOTBRIDGE AWARDS 2014

WilkinsonEyre.Architects

MEDIA CITY FOOTBRIDGE
SALFORD

The Media City Footbridge spans the Manchester Ship Canal and is a signature element within the redevelopment of the region; former industrial docks located along the canal now provide a new home for the BBC.

The area has been redeveloped by The Peel Group; Peel was the client for the £9.5 million bridge which provides pedestrian access into the heart of the fast expanding Media City development. Funding was also provided by the North West Regional Development Agency.

The design team, led by engineer Rambøll (formerly Gifford), was appointed in 2007 and work began on site in July 2009. The bridge was constructed by Balfour Beatty Civil Engineering who appointed Rowecord Engineering as their steelwork subcontractor. The bridge was completed in spring 2011.

The Media City Footbridge is an asymmetric, cable-stayed swing bridge. The design is highly contextual and provides a spectacular southern pedestrian gateway to the development. The whole structure moves as the bridge opens to allow ships to continue their journey along the Ship Canal. The weight of the bridge's rotating "piazza" is used to balance the bridge as it opens and to prevent overturning. The bridge itself will sustain live activity, social gathering, and user interaction with the unique setting, actively enhancing the Ship Canal and the Quays as a living amenity.

In order to minimise the height above the water of the bridge deck and consequently to alleviate the gradients and length of approach ramps, the curved edge of the deck is supported from above by tensile stay cables. Structure beneath the walking surface of the deck is minimised in order to provide the bridge with an elegant lightweight appearance. The cable stayed solution is also a cost-effective structural form for the length of crossing.

The dramatic form of the cable array draws views and pedestrians from all directions. The centrepiece of the space is a distinctive mast formed from the fanned array of individual pylons which support the stay cables.

Up to 30m tall, the masts converge at their base atop a steel pedestal to create a highly visible and distinctive focal point above the pivot of the bridge. Although the masts are a direct functional response to the forces flowing thorough it from the stays above, their shape is emblematic and instantly memorable.

The bridge was completed significantly under the original budget and by the scheduled date. It was opened by the Archbishops of Canterbury and York in early March 2011, and was officially opened to the public in May 2011.

WilkinsonEyre.Architects

For the art project "EmscherKunst.2010", the renowned artist Tobias Rehberger envisioned a colourful ribbon wrapped in a wild, swinging, erratic, and monumental spiral that would connect the existing parks and undulate over the Rhein-Herne canal like a rope flung across the water.

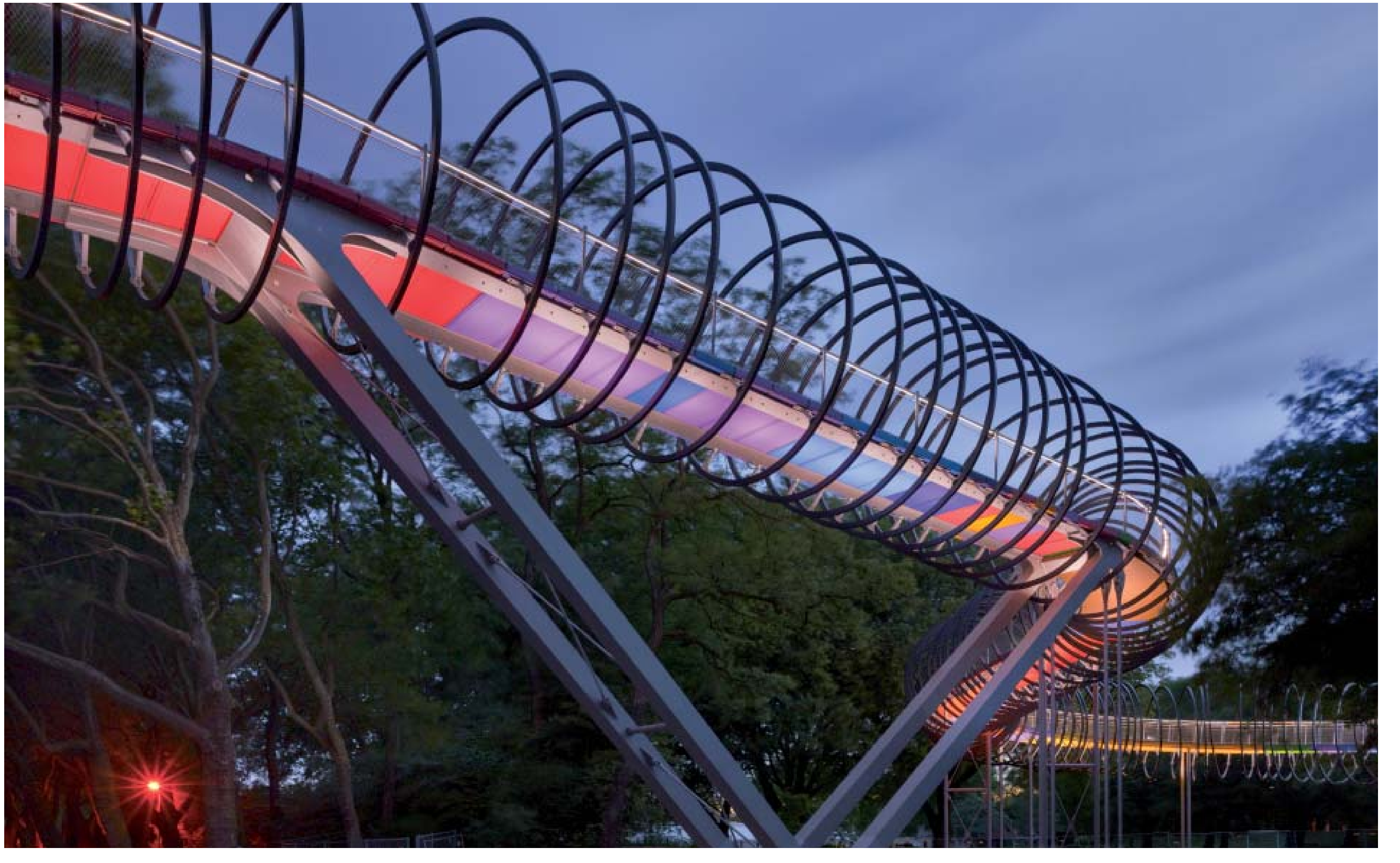
Already during daylight the cooperation project of the artist and the structural engineering firm schlaich bergermann und partner is a mesmerising experience, evoked by the colours applied on the bridge surfaces.

At night, the dark spiral vanishes into the background, and the superstructure takes its place, meandering through the park in a radiant and colourfully perceptible way. LED lamps genuinly render the pleochroism of ramps and bridges.

The LED lamps were used consistently and incorporated into the structure: on top of the bridge in the railings, and underneath at the low points of the spiral. Shining in „daylight white", the highly efficient lamps are mounted almost invisibly and guide pedestrians across the colourful paving.
Due to the quality of lamps and light, the colour is as brilliant as it can be. Looking at "Slinky springs to fame" from a distance, the impression is that the bridge radiates light itself.

Art and construction
The design, a colourful pedestrian bridge which was inspired by a toy has been transformed into a new landmark in Germany, named «Slinky springs to fame».

The sculptural bridge (total length 406m) had to be fitted carefully into the sensitive surroundings. For various reasons, it was impossible to build foundations for the main bridge right next to the canal.



To keep the span of the main bridge across the canal to a minimum it was designed as an elegant and lightweight three-span stress ribbon bridge with a span of 66m in the middle and 20m each in the two side spans.
The walkway consists of 2.67m wide and 12cm thick pre-cast concrete panels, bolted to the stress ribbon, to which the railings - consisting of cable nets, steel posts and steel tubing - as well as the spiral are attached.
The complete footbridge is wrapped in an undulating spiral (5m diameter) made of an aluminium hollow section bolted to the bridge's structure.

Colorful event
Rehberger designed the tartan-like covering with fields at various lengths, for which he selected 16 different colours. These colourful fields continue on the bottom side of the ribbon. At night the superstructure meanders clourfully and bright through the park, with the spiral hardly perceptible - it primarily attracts attention during the day. The dynamic and colourful figure has been combined with a lighting concept that controls the illumination of the bridge at night.
The «sculpture that is a bridge as well»; and also the «structure that is an art object at the same time», connects functionality with a convinving aesthetic concept.

The night illumination with its colourful pavement pathway was meticulously planned in order to match the colours on top, as well as on the bottom. The springy synthetic pavement and the colourful rhythmisation of both concrete and coating amplifies the dynamic experience of the bridge. The pavement features a synthetic and elastic seamless floor covering system, as it is normally used for protection surfacing on playgrounds. The wear-layer consists of a solid-coloured EPDM.

Lighting concept
Together with the engineering firm the artist developed a lighting concept for the accessible sculpture. At night, the dark spiral vanishes into the background, and the superstructure takes its place, meandering through the park in a radiant and colourfully perceptible way.

The lighting alters with seasonal variation of sunrise and sunset. The system features a dimmer switch. In summertime the lighting would be switched on at 10 pm, and off again at 5 am. During the summer holidays the programming time to turn the lighting on would be brought forward to 8 pm.

For this purpose, one of the two handrails was continously equipped with Ledlux-LH-LED lamps by Insta that is over a structure length of 406m. The lamps with the colour 7.300oK daylight white have been mounted almost invisibly and guide the passers-by over the colourful floor whose luminosity does not suffer at all, due to the quality of lamps and light.

Narrow spot angles and the exact orientation of the lamps avoid glare to the shipping traffic. The highly efficient lamps with the cool colour 7.300oK daylight white have been mounted almost invisibly and guide the passers-by over the colourful floor. The selection of lamps and light quality even increases luminosity of the super surface.

When looking at "Slinky springs to fame" from a distance, the impression is that the bridge radiates light itself. This is due a particularly bright custom-made design for this construction project: 300 lamps of the extra-bright version of instalight 1060 have been intalled at every minimal turning point of the spiral to emit diffused lighting across the bottom view of the bridge.
To achieve equal quality, the same lighting colour (7.300oK daylight white) has been selected to present the pleochroism at the bottom of the superstructure.

LED lighting also makes the bridge safe to be crossed in the dark. The LED lamps Ledlux Linear have been integrated into

LED lighting also makes the bridge safe to be crossed in the dark. The LED lamps Ledlux Linear have been integrated into the handrail in such a way that they exclusively illuminate the running surface without dazzle. However, they are invisible in the overall view and not tangible for the pedestrian’s hand. The bridge establishes previously unknown visual connections with the surroundings. And its shiny and colourful luminosity fills people with wonder and joy.