

e-mosty

02 / 2019 JUNE

RICHARD COOKE ON BRIDGES

Blythe Park Bridge



LIST OF CONTENTS

Special Acknowledgement (Turkey) <i>Magdaléna Sobotková</i>	4
Richard Cooke on Bridges	12
Interview with Richard Cooke <i>Derya Thompson</i>	39
Richard Cooke´s CV	45
A community Approach to Enabling Sustainable Footbridges <i>Matthew Bowser, Débora Bowser, Bridging the Gap Africa</i>	52
How to Carry out Maintenance Work with Minimal Traffic Disruption <i>Robert Percy, COWI</i>	60
Award Ceremony of the "BERD-FEUP WIBE" Prize <i>Brigitte Rouquet, BERD</i>	62

Front Cover: Blythe Park Bridge. Photo Credit: CJB Photography
Back Cover: Oltulelei Bridge. Photo Credit: Micah Conway

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Dear Readers

First of all, let me express my gratitude towards all people and companies that so warmly welcomed me during my trip to Turkey – çok teşekkür ederim. More details are in the Special Acknowledgement that follows this editorial.

This special issue is dedicated to Richard Cooke. His professional career is described in a more detail later so let me just say a few personal words here.

He became the very first Member of our Editorial Board in Spring 2016. At first he helped me with our e-mosty June 2016 about the Osmangazi and Yavuz Sultan Selim Bridges. Since then, he has always been helpful and has assisted me with every issue, always ready to provide advice and a helpful hand.

I am happy he accepted my offer last summer and prepared the content of this issue. Thank you very much, Richard.

His article named “Richard Cooke on Bridges” is followed by an interview led by Derya Thompson to whom I also thank.

Additionally there is also Richard’s CV which describes the most significant projects he has participated in, his lectures and publications.

Our magazine promotes Bridging the Gap Africa. Their team prepared for us an article about Oltulelei Bridge in Kenya.

The final technical article of this issue was prepared by Robert Percy of COWI UK and is about bridge maintenance with minimal traffic disruption.

The report on the WIBE Prize was prepared by Brigitte Rouquet from BERD.

I would like to thank to Ken Wheeler for reviewing this issue.

We invite you to contribute to our magazine with your ideas, information about your projects, articles, photos etc.

We also offer you partnership with our magazines e-mosty and e-maritime.

Editorial Plan and more information about partnership can be found on pages 10 and 11. For more information and detailed arrangement please contact us by e-mail.

Follow the magazines on LinkedIn

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Magdaléna Sobotková

Chief Editor

Special Acknowledgement

In May 2019 I visited Turkey. The plan was to visit the Osmangazi Bridge, Yavuz Sultan Selim Bridge, construction of the 1915 Çanakkale Bridge, and also to visit some shipyards and companies involved in the maritime industry.

I would like to thank to all the people involved for their time, assistance and very kind welcome and I look forward to our future cooperation.

All of your achievements are admirable and allow me to focus on them in some detail on the following pages, including links to our previous editions of e-mosty magazine where we typically describe the design, construction, operation and maintenance of the bridges, including drawings, photographs and video.

OSMANGAZI BRIDGE

The Osmangazi Bridge, with its main span of 1550m, is the fourth longest span suspension bridge in the world. It forms a part of the Gebze-Izmir motorway and crosses the entrance to Izmit Bay in Turkey.

The 252m tall H-shaped towers are stiffened steel plate box structures. The suspended deck is a 35.93m wide and 4.75m deep single streamlined orthotropic steel box girder deck, continuous over three spans 566m+1550m+566m. Construction started in 2013 and the bridge opened to traffic on 30 June 2016.

Read about its Design and Construction [here](#), Operation and Maintenance [here](#), Vessels and Equipment Used for its Construction [here](#).

Richard Cooke also briefly focuses on the Bridge in this issue, on page 37.

Thank you, Fatih Zeybek, for showing me the bridge, with explaining its technical details, and for showing me the Bridge Museum.

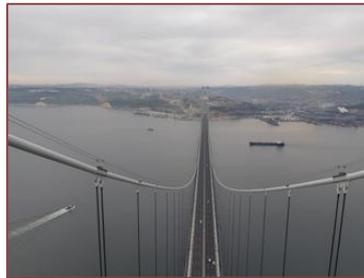
Photo Credit: e-mosty, with permission of OTOYOL YATIRIM VE İŞLETME



Approaching the Bridge



The South Tower



View from the South Tower



Museum of the Bridge

YAVUZ SULTAN SELIM BRIDGE

The Yavuz Sultan Selim Bridge (3rd Bosphorus Bridge) is a hybrid suspension cable stayed bridge (HRSB - Highly Rigid Suspension Bridge) for road and rail traffic. It is located in the Odayeri – Paşaköy area of the Northern Marmara Motorway project in Turkey.

The main span is 1,408m in length with approach spans of 378m on each side. The 58.5m wide streamlined steel orthotropic deck supports a two-carriageway motorway with four lanes in each direction, in the future separated by a planned twin-track high-speed railway system in the centre.

The towers are A-shaped. Each tower comprises of two cylindrical reinforced concrete shafts below ground and two triangular legs. The height of the towers is 322m.

Works commenced in 2013. The bridge opened to traffic in 2016.

Read more about the bridge in our magazine e-mosty June 2016 [here](#).

Thank you, Burak Isik and Ayçe Yilmaz Canli, of ICA (IC Ictas – Astaldi JV which is the operator of the bridge and the motorway) for showing me the bridge and for your time and assistance.



Photo: e-mosty

1915 CANAKKALE BRIDGE

The 1915 Çanakkale Bridge (in Turkish 1915 Çanakkale Köprüsü) is located 200km southwest of Istanbul, spanning the Dardanelles Strait, which connects Lapseki District to the Gelibolu District (Gallipoli). The main structure will be 3-span steel suspension bridge.

The main span of the bridge will be 2,023m, the bridge length will be 3,563 m and together with two approach viaducts the total length will be 4,608 m.

The towers will be 318m high. Each tower is founded on a cellular concrete caisson measuring 83m by 74m in plan.

The deck of the bridge will be at a maximum height of 72.8m above sea level and will have a total width of 45.06m and an overall depth of 3.5m.

The deck will carry six lanes (three in each direction), together with two maintenance walkways on each side. Works commenced in 2017.

Planned opening of the bridge to traffic is 2022/3. At this time the bridge is going to be the longest span suspension bridge in the world.

Read more about design of the bridge in our e-mosty March 2019 [here](#).





Caisson for the European Tower installed in the Dardanelles Strait



Caissons for the Asian Tower ready for installation



MUM used for levelling the seabed

Photo Credit: e-mosty and Aras Marine

ARAS MARINE

Since its foundation in 1995, ARAS Group Companies have been serving in national and international waters to various world class Clients in marine construction and offshore sectors with its reliable management, experienced staff, expert divers, powerful fleet and technological underwater equipment. Shortly after its establishment in Istanbul, ARAS extended its presence in several other countries in Europe, Middle East and Africa.

“Future of a company may only be secured with its adaptation capability to global market, and time of reaction to the requirements of fast evolving demands.” Today, ARAS Group continues its services and strengthens its presence in 8 countries, with total manpower of approximately 500 people.

In salvage tug management and marine construction ARAS Marine is one of Turkey's leading private sector companies.

The company has ISO 9001: 2015 Quality Management System, OHSAS 18001: 2007 Occupational Health and Safety Management System and ISO 14001: 2015 Environmental Management System Certificate and International Ship Rescue Association (ISU, International Salvage Union) in London.

In addition to being a full member, it has been implementing International Safety Management System since 2002 and International Ship and Port Facility Security (ISPS) (International Ship and Port Facility Security Code) (ISM) since 2004.

Aras Marine has provided marine services and operations for construction of all three bridges.

In e-mosty in September 2018 [here](#) you can read more about their involvement in the Osmangazi Bridge Construction.

We agreed on an article for e-mosty September 2019 (about Vessels and Bridges), where Aras Marine will provide an article about MUM and vessels used for the 1915 Çanakkale Bridge, and an article for our magazine e-maritime in March 2020 (Shipyards and Marine Industry in Turkey).

Thank you Umut Karakaya, Turgay Yildiz, Naci Hoscan and all the team of Aras Marine for your kind welcome to your company in Tuzla, for taking me to see the construction site of the 1915 Çanakkale Bridge, showing me your MUM Equipment (Formerly ULE – used for the Osmangazi Bridge) and explaining some technical details and its operation.

Pdf presentation of the company:



GEMAK

Gemak was established in 1969 as a small yard in the Bosphorus, Istanbul. Gemak Group now stands out in Turkey and around the world for its wide range of skills and technical expertise.

Gemak has the vision to be the best in class and preferred partner on worldwide basis for demanding projects on steel fabrication industry, marine and offshore vessel building, marine conversion projects, marine vessels repair and maintenance.

Gemak Group consists of Gemak Tuzla Shipyard (established in 1969), Gemak TGE Shipyard (acquired in 2000), Gemak Neta Factory (established in 2008) and Gemak Altinova Shipyard (established in 2013) totally on 336.000 m².

The milestones in Gemak's history are linked inseparably to projects which is not only financially a factor of innovation, change and foresight, the levers that contribute to expanding frontiers and creating progress for the company.

Pdf presentation of the company:



50 years of experience in engineering solutions, Gemak is proud of being in service to over 2.800 ship owners and managers. The group continues to provide services for dry-docking, ship repair & conversion, offshore – oil & gas and new ship building as the one of the most competitive shipyard in the Mediterranean.

The Group has been profiled as a leading fabricator of high quality large steel constructions in the wider region with its advanced infrastructure by building steel shafts for Izmit Bay Bridge and by fabrication of steel decks for 3rd Bosphorus Bridge.

The Group strives to bring benefit to its clients by combining strengths generated by involvement in these main activities.

Gemak employs nearly 3.000 people of which 170 are engineers. Gemak engineering professionals are multi-disciplined and each is experienced in many product lines.



Transportation of a deck segment for the Yavuz Sultan Selim Bridge by Dynamic Positioning Vessel

Thank you very much Kaya Yaşar for your time and great presentation of your company.

Gemak will prepare an article for our e-mosty September 2019 and e-maritime in March 2020 (Shipyards and Marine Industry in Turkey).

Apart from that, thank you Fatih Zeybek (OTOYOL YATIRIM VE İŞLETME), Erdal Ergül (STFA 's Ex-Project Manager) for the Osmangazi Bridge, and Özcan Başkazancı (TEKFEN Engineering), for your support and assistance.

*Magdaléna Sobotková
Chief Editor*

e-mosty

The magazine e-mosty ("e-bridges") is an international, interactive, peer-reviewed magazine about bridges.

It is published on www.e-mosty.cz and can be read free of charge (open access) with possibility to subscribe.

It is published quarterly: 20 March, 20 June, 20 September and 20 December.

The magazines stay available on-line on our website.

It is also possible to download them as pdf.

The magazine brings original articles about bridges and bridge engineers from around the world. Its electronic form enables publishing of high-quality photos, videos, drawings, links etc.

We aim to include all important and technical information and show the grace and beauty of the structures.

We are happy to provide media support for important bridge conferences, educational activities, charitable projects, books etc.

Our Editorial Board comprises bridge engineers and experts from the UK, US and Australia.

The readers are mainly bridge engineers, designers, constructors and managers of construction companies, university lecturers and students, or people who just love bridges.



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RUBRICA **BRIDGES**

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e-maritime

The magazine **e-maritime** is an international, interactive, peer-reviewed magazine about vessels, ports, docks and maritime equipment.

It is published on www.e-maritime.cz **three times a year**:
30 March, 30 June and 30 November.

September Issue is shared with the magazine e-mosty (“e-bridges”):
“Bridges, Vessels and Maritime Equipment”
which is published on 20 September on www.e-mosty.cz.

It can be read **free of charge** (open access) with possibility to subscribe.
The magazines stay **available on-line** on our website.
It is also possible to download them as **pdf**.

The magazine brings **original articles about design, construction, operation and maintenance of vessels and maritime equipment, docks and ports from around the world.**

Its electronic form enables publishing of high-quality photos, videos, drawings, links etc.

We aim to include all important and technical information and show the grace and beauty of the vessels and structures as well.



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Editorial Plan

e-mosty September 2019

Bridges and Vessels - their interaction; design; protection of bridges in navigation channels and with regard to ship impact and related topics. Vessels and Equipment Used for Bridge Construction

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e-maritime November 2019

Ports, Docks, Jetties and Piers
Design, Construction, Operation
and Maintenance

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European Bridges

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e-maritime March 2020

Shipyards and Maritime Industry
in Turkey

Drafts by 30 January
Release 30 March

e-mosty March 2020

Floating Bridges

Drafts by 10 February
Release 20 March

Offer of partnership and promotion of your company in our magazines e-mosty and e-maritime

Partnership can be arranged with both magazines, or with each magazine separately.
We can also agree on partnership covering only one specific issue.

The partnership scheme typically involves:

- Your **logo on the main page** of our website.
- 1 page interactive **presentation of your company in every issue.**
- Your logo and / or the name of your company on **every publication and output we release.**
- Continuous promotion of **your company and projects in our social media.**
- Publication of one **technical article** during the year (which we can help you prepare)

Both **the price and the extent of cooperation are fully negotiable.**

Please [contact us](#) for more details and partnership arrangement.

e-mosty

e-maritime

The magazine [e-mosty](#) was established in April 2015 and its first issue was released on 20 June 2015 as a bilingual English – Czech magazine aimed mainly for Czech and Slovak bridge engineers.

Very quickly it reached an [international readership](#).

In 2016 we extended the already existing Czech and Slovak Editorial Board by two bridge experts from the UK, and since then four more colleagues – from the USA, Australia and The Netherlands – have joined us.

Since December 2016 the magazine has been published solely in English.

Each issue now has [thousands of readers worldwide](#).

Many of our readers share the magazine in their companies and among their colleagues so the final number of readers is much higher.

Most importantly the [readership covers our target segment](#) – managers in construction companies, bridge designers and engineers, universities and other bridge related experts.

The magazine [e-maritime](#) was established in 2018 and its first issue was released on 30 March 2019.
It has had more than 500 hundred readers in a few weeks.

The magazine is published in English. It is going to cover a vast range of topics related to vessels, maritime equipment, ports, docks, piers and jetties - their design, construction, operation and maintenance, and various maritime and construction related projects.

The Editorial Board already has two members – from the UK and the Netherlands.

Both magazines are with [Open Access with possibility to subscribe](#) (free of charge).

In January 2019 we established their own [pages on LinkedIn](#) with constantly increasing number of their followers.
Number of [subscribers](#) of both magazines is also increasing.

We also know that the readers usually go back to older issues of both magazines.

RICHARD COOKE ON BRIDGES

INTRODUCTION

I have always been fascinated by physics and technical problems and considered myself very fortunate as my scientific interests guided me directly towards a fulfilling career in civil engineering.

At various times opportunity, or possibly fate, took a hand in shaping the advice or experience I received. This included an early visit to the offices of Kenchington, Little and Partners in Harrow, London who were undertaking the design of various building projects.

Lawrence Kenchington himself was a family friend, and later, while I was at Oxford University studying Engineering Science, I met up with him one summer's afternoon. He had founded KLP over 30 years previously and it had grown to several hundred staff. He gave me much encouragement and some invaluable advice.

I remember two specific things.

Firstly, always have a comprehensive filing system for information which could accommodate the widest range of subjects or categories that could be imagined. At some stage it would be filled with reference information which might be useful later.

When storing any document he advised me to assign it to the first topic that came to mind because when at some future time I might need to retrieve it, that would be the first place that I would probably look for it.

He was right! On many occasions, whether as part of my old paper system, or now in my electronic library, finding those documents to help with a contemporary problem, or to provide advice to colleagues, has generally only taken a few minutes of looking, and without using the search assistant.

Secondly, Lawrence described his objectives in the recruitment of staff. He explained that all employers need people with a wide range of skills and attributes. In engineering, very clever, highly numerate and technically capable people can always be found, but he was looking for more in his key leaders.

He was looking for ambassadors – engineers who could not just solve technical problems but could also promote his business, sell their capabilities and win project work.

He emphasised the need to take a broad view of all aspects of work, as focussing too narrowly or being too specialist, might not fulfil the needs of a project. I have always borne this in mind in the course of my career.

Every project needs to be delivered to a timescale and budget, as well as satisfying the brief and solving a whole range of constraints.

Even though I knew I wanted to be a structural engineer, my Engineering Science degree was also helpful as it covered the whole range of engineering subjects including mechanics, thermodynamics and electrical properties of materials.

It also focussed on the theoretical side and the need to solve problems from first principles. These attributes, with a broader understanding of other engineering skills, would come in useful later when working in a multi-disciplinary team environment.

My university education system encouraged self-learning and curiosity and the engineering science degree had a voluntary option to study Structures.

Based on scientific theory it meant I learnt many things from first principles and would then solve problems in the same way. Oddly I had no working knowledge of design standards when I graduated.

Of course, as I worked on schemes I followed codes of practice and specifications, but real projects don't always follow the 'rules'.

Physical constraints and the structural behaviour of an element sometimes need a bit of lateral thinking to achieve the desired analytical result.

Final design solutions that appear to be elegant and efficient for their requirements are often only arrived at after many iterations.

In my own experience the challenge was to get to that point as efficiently as possible.

My formative experience included employment before and during university with Ove Arup and Partners.

Arup have always adopted a philosophy in which delivering project quality and client satisfaction are

essential to producing the best scheme and ensuring staff satisfaction.

Their reputation and international presence soon impressed me, and I was fortunate to be offered a graduate post on completion of my degree studies.

My pre-university experience involved working in Highways and Transport Planning.

Later when I graduated, I wanted to work in the Bridges group and this has always been my central interest.

I was told many years later that I was one of the first such trainees as part of a new recruitment initiative to invest in potential graduates.



I have always appreciated the opportunities this gave to me, not least I was often doing those tasks essential for successful delivery of a project such as manually preparing drawings and getting them printed which always takes thought and planning.

Now our methods and techniques have advanced in ways few of us could have predicted but understanding the contribution of all members of the team, at all stages, is essential for successful scheme delivery.

For this article I will describe a select number of projects or topics which have shaped my experience and taught me some important technical or practical principles which have been invaluable for future reference. I have always believed in a diverse and flexible attitude to undertaking projects, and these have included:

- feasibility investigations
- analysis, design and checking
- construction methodology and temporary works
- bridge inspection and assessment
- modification of structures
- structural performance and durability
- long span bridge implementation

← *Figure 1: Runnymede Bridge – My earliest bridge experience in a scenic location over the River Thames © Arup*

Foyle Bridge, Derry

The scheme involved the independent checking and supervision of a 522m long 3-span steel box girder bridge with 350m long 7-span post-tensioned concrete approach viaduct being built across the River Foyle in Northern Ireland.

The bridge carries a dual 2-lane carriageway, comprising two identical parallel structures separated by a longitudinal joint.

The history behind the scheme was very important as this was one of the first major steel box-girder bridges built after the tragic collapse of 4 bridges between 1969 and 1971, the most notable of which was the Westgate Bridge over the Yarra River in Australia.

Each collapse was caused by slightly different sequences of events, but the common cause was the sensitivity of the stiffened steel plates to buckling especially if they had geometrical imperfections – particularly lack of straightness.

The Merrison Committee published their recommendations in 1972 and a much higher level of attention was then paid to all bridges that were designed afterwards.

I was part of the independent checking team and learnt about many of the principles of structural behaviour. This was made even more complicated by the chosen method of construction.

The steel bridge comprised about 5000 tonnes of fabricated steelwork and the necessary emphasis on workmanship quality required a highly skilled work force.

To make best use of resources a logical choice, made early in the project, was to manufacture the main bridge sections at the Harland and Wolff Shipyard in Belfast. The yard was established in 1861 and is famed for building the RMS Titanic amongst many other ships.

The aim was to build the box girder in 6 major sections. The four side span/cantilever sections measured 180m long and weighed 1000 tonnes each.

The sections were fully constructed in the shipyard and were then to be shipped on a sea-going barge to site around the north coast, a distance of over 150km.

The journey would take about 2 to 3 days and it was realised that the weather conditions would need to be calm with wind conditions no greater than Beaufort Gale Force 5.

Even these could result in significant rolling, pitching and yawing of the barge. The predicted rolling was up to 20 degrees.

I discovered a major omission in the analysis and design of the steel sections during the transportation of the bridge from the fabrication yard to site.

The barge behaviour in sea conditions caused by winds up to Beaufort Gale Force 5 were provided by Lloyds Shipping and indicated possible longitudinal pitching of +/-10 degrees and transverse rolling of +/-20 degrees.

These are actions that a static bridge will not normally experience, and I realised that during the transverse rolling condition self-weight load would be concentrated through the bearings on one side only, effectively doubling the load requirement, and this ignored any dynamic aspects.

The bearings and temporary support points had not taken this into account and the plate girders would have buckled as well.

The solution required that additional propping was advisable to ensure that the bearings were not damaged in the event that the barge was caught in a storm during the 2-3 day passage from ship yard to site.

Once the barge arrived at the site the side span sections were off-loaded using self-propelled multi-wheel transporters, with the ballast in the barge constantly adjusted to keep it stable at the 1000t sections moved longitudinally.

The project was an excellent example of the benefits of combining the skills of the Designer, Contractor and local skills base, an early form of applying Design and Build principles to achieve the most effective solution.

Learning Points

In addition to the core skills needed for structural analysis, I learnt that it is essential to have a wider understanding of a project to fully appreciate special aspects that could be critical to its success.

The original concept for the whole project demonstrated the benefits of planning key elements of the works using skilled resources and specialist methods of construction.

The scheme also introduced me to the use of major temporary works plus transportation methods, including the use of major lifting equipment and self-propelled multi-wheeled transporters which would be invaluable experience for use on later schemes.



Figure 2: Foyle Bridge side span girder weighing 1000 tonnes during transport to site



Figure 3: Side span girders being lifted to final level



Figure 4: Lifting centre span

Kylesku Bridge, Scotland

This project was one of the first in which I was introduced to the analysis and design of a complex curved, 5-span post-tensioned concrete bridge.

Although the alignment of a route may be dominated by specific features of the site or preferences of the client/designer, generally bridges need to follow the optimum alignment required for the highway, railway or footway carried.

This was particularly the case for the Kylesku Bridge in Scotland. Crossing a natural inlet between two lochs the route sweeps around to best fit the steep sided topography on each side of the water.

As part of a dedicated team of designers, I soon learnt about the fundamental principles of post-tensioned concrete bridge analysis coupled with the complex, curved geometry.

Coincidentally part of the construction method for the centre span was similar to that used for the Foyle Bridge but this was a construction decision and was not a design requirement.

The bridge's vertical clearance was governed by the need for specific shipping, and the bridge was opened by Her Majesty Queen Elizabeth II in August 1984, travelling to the site on the Royal Yacht Britannia.

Learning Points

Knowledge of the method of construction is important. The designer needs to understand how the bridge might be built. However, the geometry, remote location and extreme weather conditions presented significant challenges.

Bridge geometry must be tailored to achieve the most desirable route alignment, even if this requires complex setting out, interdisciplinary co-ordination and a higher level of technology for construction. This is especially true for railway projects when the operation and performance aspects must be prioritised.

A recent visit to the bridge, more than 35 years after completion, illustrated that the quality of design, detailing and construction has served the bridge well.

The bridge complements the spectacular and dramatic landscape – a valuable lesson in aesthetics, which all engineers must appreciate and consider in any scheme they undertake.

→ Figure 5: Kylesku Bridge – centre span construction

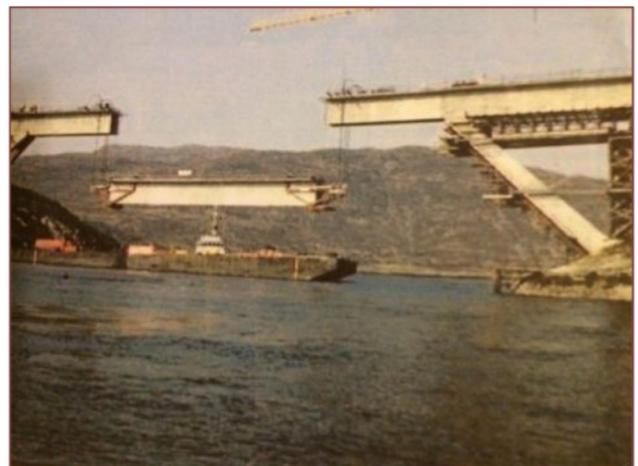


Figure 6: Kylesku Bridge
Elevation on pier



Figure 7: Kylesku Bridge
V-shaped piers supporting curved deck



Figure 8: Kylesku Bridge, Scotland © Arup

M40 bridges designed for Mining Subsidence

The long-term transport strategy to build a second motorway between London and Birmingham had eventually been commissioned by the UK government with planned completion in the early 1990s.

It was being constructed in several sections, typically 12 to 15km in length with the final 6 sections connecting Oxford to the M42 motorway south-east of Birmingham.

From the 1960s to the 1980s the majority of bridges for UK motorways and trunk roads were being designed using a standardised methodology and favouring the use of simply supported precast, prestressed beams.

This approach was considered an economical way to get simplified and repetitive solutions using factory made precast prestressed concrete beams supported on abutments, walls and trestles.

Every span was jointed, which avoided concerns about differential settlement, but it was not long before serious defects began to materialise with widespread reports of the failure of movement joints, leakage of salt-laden water and serious corrosion damage to concrete, steelwork and bearings.

As I will describe later, in connection with my interest in Integral Bridges, the benefits of structural continuity would minimise the provision of movement joints, particularly over intermediate supports. The majority of bridges were overbridges and we developed a family structural identity as shown in Figure 9.

However, as part of the scheme development and consultation process, it was found that major deposits of the North Oxfordshire Coalfield existed at depths between 700 and 1100 metres with seam depths up to 4.6 metres thick.

Using advice from the National Coal Board, based on 'longwall' extraction methods, we predicted potential ground movements and differential settlements.

The coal extraction leads to a 'wave' of settlement causing curvature and twisting as well as compressive and tensile strains at the ground surface.

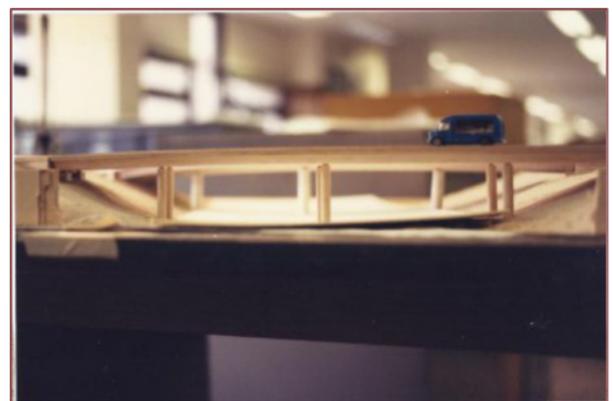
In simple terms we predicted differential settlements between successive supports which might be up to about 25mm, but this was in addition to normal ground settlement.

We calculated structural increases in moment and shear of up to 20% at key locations. Also ground strains could be in excess of 1% which would damage the abutment movement joints. All bridges were designed to have sufficient capacity to accommodate the increased load effects, movements and settlements.

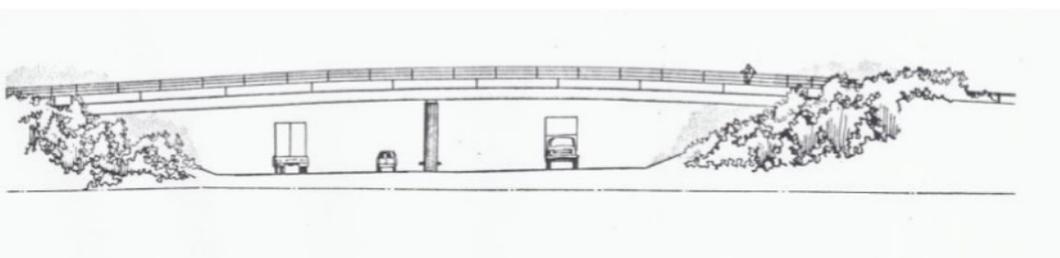
We developed a concept for the layout of the abutments that would facilitate changes during and after a mining subsidence event. This entailed having non-critical sections that could be easily removed before the ground movement affected the bridge. After subsidence had passed, the bridge would then be repaired to suit the final geometry.

To test the suitability and flexibility of the concept we prepared both drawings and models to ensure that the aesthetics of all of the bridges would be acceptable. Every bridge was reviewed to ensure it was suitably integrated into the landscape and also that its layout would facilitate future inspection and maintenance.

In the course of developing these proposals, one of our prime objectives was to establish an identity for all the bridges to create a family of types that provided uniformity. This has several advantages as the structural similarities allow the Contractor to achieve consistency and economy.



↑ Figure 9: Modelling to verify aesthetics



← Figure 10 : Typical 2 span bridge (some locations had 4 spans)

One of my mentors impressed on me the need for 'unity and variety' which means that every structure would adopt a common style, with similar detailing, but at the same time be identifiable in its own specific location, adapted to suit any individual constraint.

The range of family types for the overbridges can be seen in Figure 11. These accommodated a range of carriage-way widths and span requirements. All of the reinforced and prestressed concrete bridge decks were designed for the additional ground settlements and flexural stresses caused by mining subsidence with just one exception.

In that case, the bridge subjected to the most severe set of ground movement parameters, had to be changed to a steel composite form as this was more structurally flexible. The use of steel elements, compared to all the other concrete bridge decks, had implications for future maintenance, but this demonstrated that all designers must be ready to deal with special cases when appropriate.

Ironically, less than 10 years after the scheme was opened, the coal industry dramatically reduced in the UK. Now, nearly 30 years after the bridges were designed and built, it is now very unlikely that coal will ever be extracted.

The bridges are still performing well but will probably never be subjected to the full range of movement and loadings for which they were designed.

However it was always prudent to make provision for the possibility as the extra costs involved were relatively small and a whole life cost assessment supported the approach.

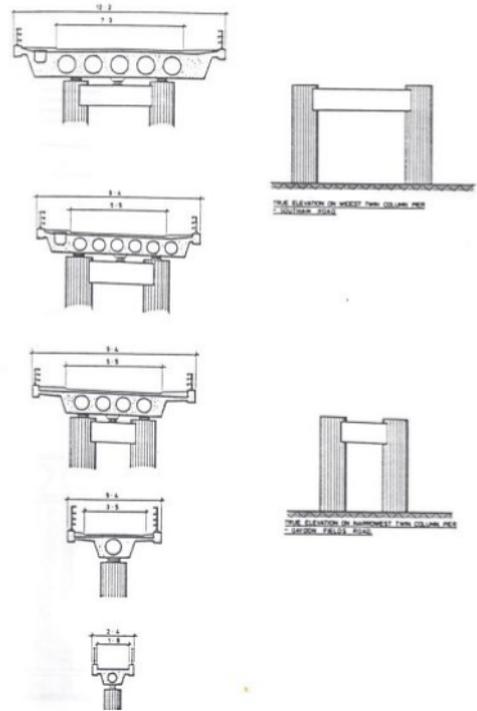
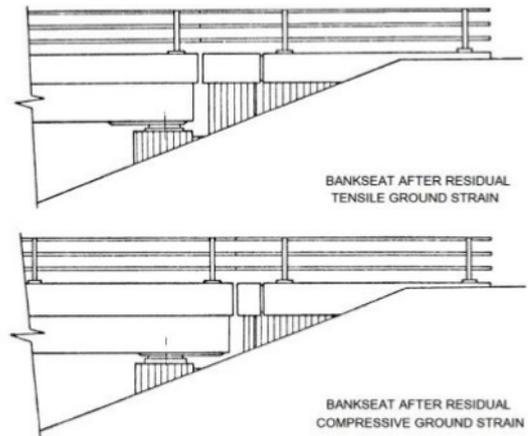
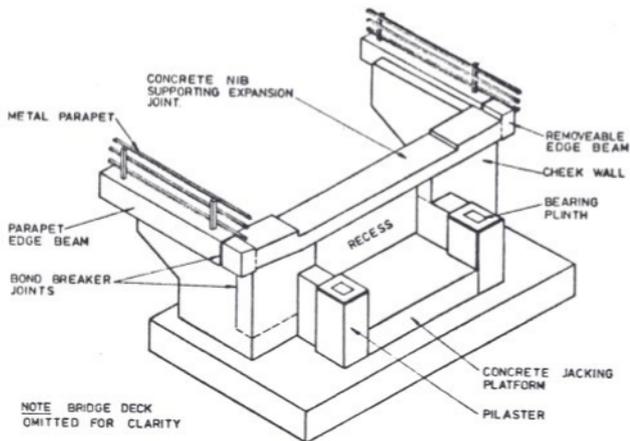


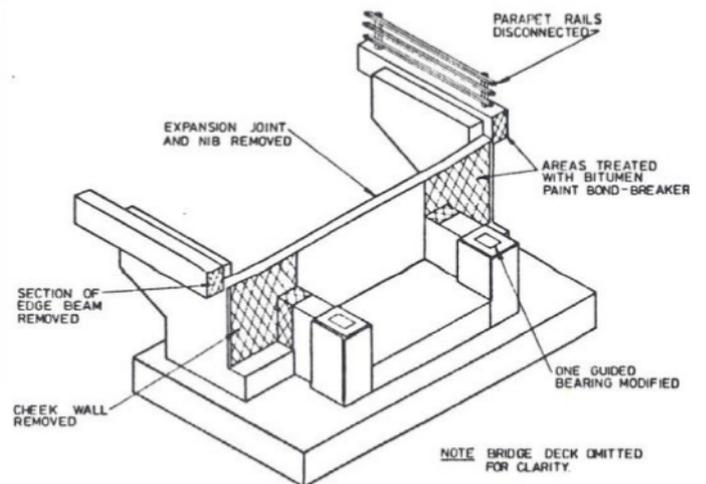
Figure 11: Family types for the overbridges



Figures 12 and 13: Reconstructed Layouts after subsidence



↑ Figure 14: Isometric view of bankseat showing key elements



→ Figure 15: Isometric view of bankseat showing altered elements during mining phase

Learning Points

The project comprised the core attributes that all bridge engineers need to exercise in the development of a successful scheme. Design is a careful balance of satisfying the technical requirements with aesthetics and constructability.

The importance of bridge durability encouraged the design team to adopt continuous construction, minimising the presence of movement joints.

This presented considerable challenges encouraging us to look at both the design requirements, essentially designing for significant differential settlements, and also the future performance and how adaptable the structures would need to be in the event that they needed to be modified.

This was a relatively unusual requirement as most bridges remain static throughout their serviceable life.

Now, 30 years later, we routinely consider the future expectations for all bridges, how their needs might change and methods for modification or removal. Sustainability is now considered an essential attribute but then we were extending the boundaries of normal practice.

This scheme also gave me the opportunity to publish my first technical paper ⁽¹⁾ and to prepare illustrative drawings and displays which were presented to an independent expert organisation for comment (the Royal Fine Art Commission) which would be invaluable a few years later when working on plans to widen motorways.



Figure 16: Mollington Valley Footbridge



Figure 17: Mature landscaping used to hide abutment/bankseats



Figure 18: Easily accessible bearings for inspection and maintenance

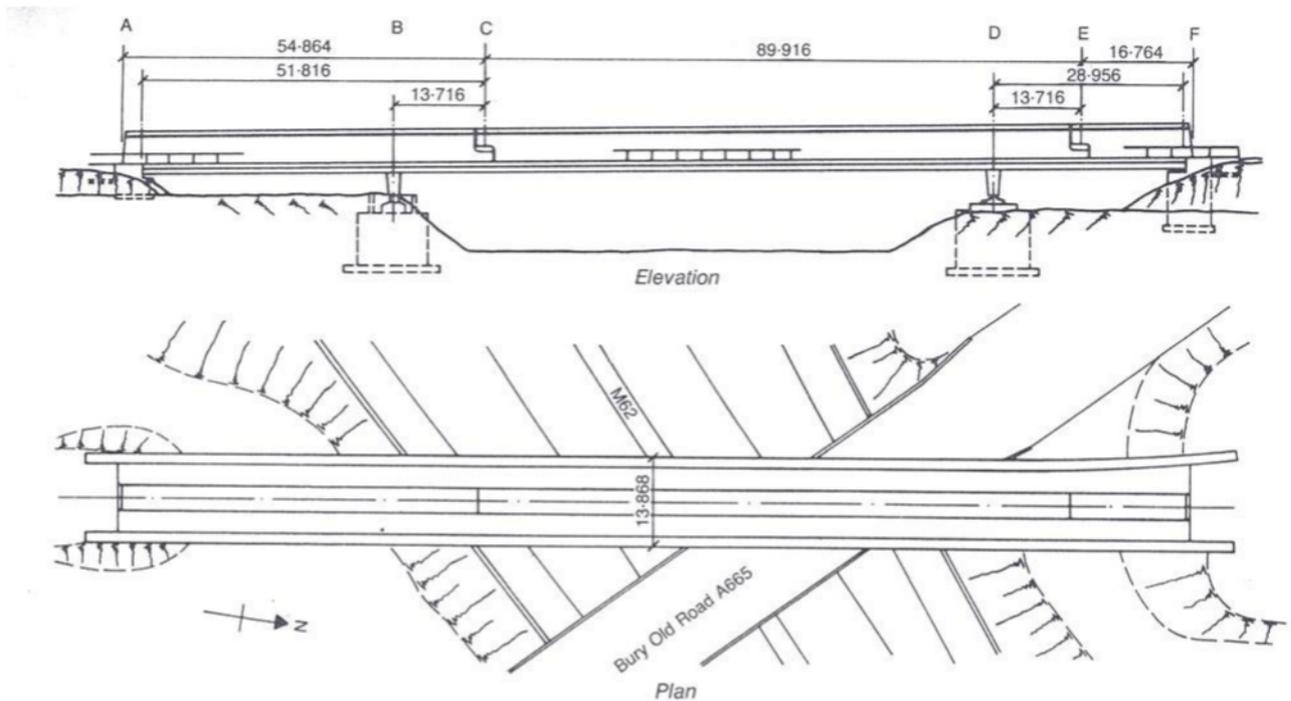


Figure 22: Layout and Plan

Critical questions immediately needed answering:

- How had the water entered the box? Presumably the top flange waterproofing had failed.
- What additional weight was being carried by the bridge and how did this affect its load carrying capacity?
- Did this impose a restriction on the allowable weight of trains?
- Did the observed cracking indicate serious structural weakness or deterioration?
- Finally, was the penetrating water affecting the post-tensioning cables and reinforcement?

We had several major concerns, the critical aspect requiring us to understand the condition of the post-tensioning system.

In 1985 a small bridge, using segmental post-tensioned construction, collapsed at Ynys-Y-Gwas in Wales without warning. It had only recently been inspected but exhibited no signs of defects or tell-tale rust staining.

Subsequently hidden corrosion of the prestressing steel wires was identified, caused by salt-laden water penetrating the insitu joints. Besses O' Th' Barn Bridge was built very differently but it had visible cracking and water trapped inside of the trapezoidal box.

The water would potentially be in contact with some of the post-tensioning steel.

We quickly undertook a review of the construction details, carried out an assessment of load capacity and investigated how to physically inspect the joints where post-tensioning cables connected the segments.

The challenge was evident in that there were over 2200 potentially vulnerable locations and we needed a non-destructive method if possible.

We were specifically looking for the places where the cementitious grout in the tendon ducts was voided, allowing oxygen to also be present creating an environment with water in which hidden steel corrosion could occur.



Figure 23: Besses O' Th' Barn Railway Bridge

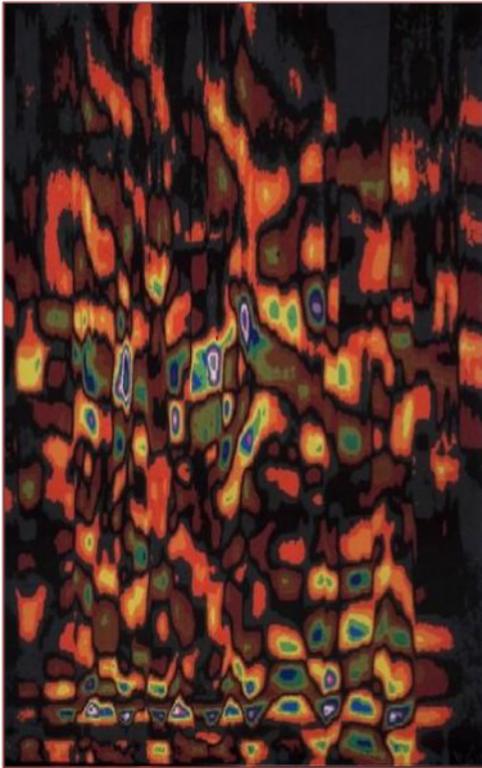


Figure 24: Radar plot showing potential voids in cable ducts

It took a progressive strategy of planning, testing, interpretation and verification to guide the objectives at each stage.

A core objective was to undertake as much of the testing non-destructively and to achieve this we undertook trials using ground penetrating radar.

The radar detects differences in density, the contrast between solid concrete and air being present indicating the possible positions of concern.

Areas coloured white in Figure 24, which is a radar scan through the 700mm thick bottom flange of the box, were the locations of possible voids. The lowest row of white areas reflects the positions of the post-tensioning cable ducts.

We then excavated some of these to verify the accuracy of the radar results. In the worst cases we found corroded and broken steel wires but fortunately these were relatively few.

Eventually we were able to conclude that the bridge could carry the required loading but ongoing monitoring and maintenance would be needed.

In 1992, not long after we had completed our studies, the Department of Transport in the UK imposed a 4-year embargo on the use of post-tensioned bridge

construction following a series of bridge collapses and other problems arising particularly in the UK and Belgium. I jointly published a paper on the project ⁽²⁾.

Separately, new industry guidance on recommended construction specifications for post-tensioned concrete construction was published in 1996.

At the same time a programme of detailed inspections and assessments for 500 existing post-tensioned concrete bridges in the UK was initiated with procedural guidance that closely matched the methodology which we had already adopted.

It was encouraging to know that the principles of our approach were endorsed by official guidance.

So what had caused the longitudinal cracks?

There were a number of theories, but for me the cracks were triggered by a combination of structural stresses, primarily torsion, together with the position of the embedded post-tensioning ducts in the bottom flange very close to the concrete surface and the reinforcement detailing.

These features created a discontinuity, and although the cracks would not be critical, we calculated that the bridge would then only carry light railway loading, equivalent to metro trains, instead of the heaviest trains it originally was designed to support.

Learning Points

This form of construction was never repeated due to its complexity and experimental nature.

The nature of the work was particularly challenging and presented many practical difficulties.

I learnt that investigation and testing of a structure is a progressive process, gathering evidence and interpreting the findings at each stage in order to focus on the next stage of work.

I have often explained to engineers new to this type of work that they should approach the problems like a detective (Sherlock Holmes?) and treat all the available facts in a forensic manner.

The challenge is to find the primary causes of the problems and to seek justified explanations and practical remedies.

Plans to widen motorways, M6 Junctions 11-16, Staffordshire UK

In the 1990s traffic growth, heavy goods transport and demand for quicker journeys across the UK resulted in a series of studies to consider how to increase the capacity of many major motorways.

Each study looked at the practicality of adding additional running lanes, typically increasing a dual 3-lane motorway to dual 4 or 5 lanes depending on forecasts.

The primary aim was to undertake this in a practical and safe manner, sometimes resolving specific congestion points at existing junctions. Three widening principles were considered:

- Symmetric widening – adding lanes on the outer edges of each carriageway, maintaining the existing centreline.
- Asymmetric widening – adding lanes on one side, retaining the opposite boundary and moving the centreline to suit.
- Parallel widening – building a completely new carriageway beside the existing route and then modifying the original pavement for the second carriageway.

Each method has advantages and disadvantages, but in trying to limit traffic disruption and ensure safety, the Parallel widening method was normally preferred although this often had the greatest capital cost.

For the existing bridges, each of the widening principles had major consequences. The overbridges were usually seriously affected as existing spans, and pier support positions, would not be suitable for the new highway layout.

By contrast, the underbridges needed to be extended transversely (on one or both sides) to provide a wider support platform, but this often had technical difficulties depending on their existing condition and the assessed load capacity of the structure itself.

So the considerations for new overbridges and underbridges presented different types of technical and practical challenge.

For overbridges, complete reconstruction was usually anticipated as the new carriageway layout would conflict with existing piers and abutments.

A further complication was incorporating flexibility for future traffic needs, with the addition of even more running lanes.

To achieve this, open span arrangements were proposed which would allow for main carriageway changes with minimal impact on the structure itself.

For underbridges, the existing structures were assessed for their suitability to carry the specified current traffic loading, even though some of the bridges were designed to standards that were 30 to 40 years out-of-date.

In many cases the designated vehicle loads have increased significantly over time.

At the same time the condition of some bridges had deteriorated to the extent that we were concerned that the factors of safety had fallen to critical levels and weight restrictions should be considered coupled with increased monitoring to check for signs of damage.

Two main options were then assessed:

- a) widening the existing bridge deck and ensuring structural compatibility in layout and behaviour or
- b) total reconstruction, which would involve major traffic diversion within the motorway corridor as re-direction of traffic elsewhere was not considered acceptable.

The high profile of the proposed works required a submission to the Royal Fine Art Commission.

The RFAC* acted as the UK Government's independent adviser on matters affecting public amenity and aesthetics in England and Wales and whose main objective is to promote design excellence in architecture and the built environment.

Presentations took the form of select high quality drawings and models to illustrate the proposals.

Fortunately I had helped with a similar submission on the M40 Bridges so I could organise the necessary resources.

** From 1999 the role of the RFAC was assumed by CABE, the Commission for Architecture & the Built Environment.*

Learning Points

The feasibility work needed to carefully consider practicality, safety, economy, aesthetics and sustainability with the aim to improve traffic capacity.

However there was also some public opposition which focussed our planning to ensure it would satisfy any independent examination or audit.

In the end only select schemes progressed to construction partly due to concerns about affordability and disruption.

This was an interesting period in in the UK's transport strategy and we published our recommendations on how the bridges might be modified to meet the scheme requirements⁽³⁾.

However the commitment by government would need major capital investment and needed to show clear benefits overall.

The bridges were just one element of a challenging scheme that would potentially create major traffic disruption while the plans were implemented.

Twenty years later the latest strategy is now called 'Smart Motorways'. This approach uses improved traffic monitoring technology, hard-shoulder running and variable speed limits so that additional flow capacity is achieved without major reconstruction of the highway pavement or bridges.



Figure 25: M6 Motorway Widening Study – Model of Overbridge after widening

The scheme was also beneficial as not long after this I was asked to write the chapter on widening bridges in the book published by the Highways Agency entitled 'The Appearance of Bridges and Other Highway Structures' published in 1996⁽⁴⁾.

As a bridge engineer it has always been important for me that in solving a problem, the end result demonstrates an improvement so that the scheme leaves a legacy for the future and enhances the environment.

Abu Dhabi 3rd Crossing

In the early 1990s the population of Abu Dhabi was only 25% of its current 1.4 million inhabitants. The emirate had been growing progressively over 40 years and highway transport access onto Abu Dhabi Island using only two existing crossings was becoming a major constraint to development.

Central to the development plan was the construction of the 'Third Crossing' a new dual 4-lane route which would provide rapid access to the international airport, 10km away, and to the main highway to Dubai.

The Emirate of Abu Dhabi Public Works Department launched an international competition inviting proposals for the crossing and surrounding highway network.

The study area covered about 24 square kilometres (8km x 3km) over which the transport network was to be improved. We had outline traffic forecasts, but the detailed solution was for us to propose.

The centrepiece would be the crossing of the Al Maqta Channel demanding a landmark bridge that would be about 500m long over the waterway.

Responding to the brief we realised that we needed a scheme that would clearly indicate the prestige of the area and a sense of arrival or departure for users.

The area is generally very low lying and topography is essentially flat with few natural landmarks. The waterway is relatively shallow, so shorter spans could be used for the proposed bridge.

Working closely with architect Arup Associates we developed a structural concept from scratch in a very short timescale.

We wanted to introduce significant height, so the bridge could be seen on the approaches and at the same time we wanted something that would be very distinctive and unlike anything that had been built before so that it would be readily identified.

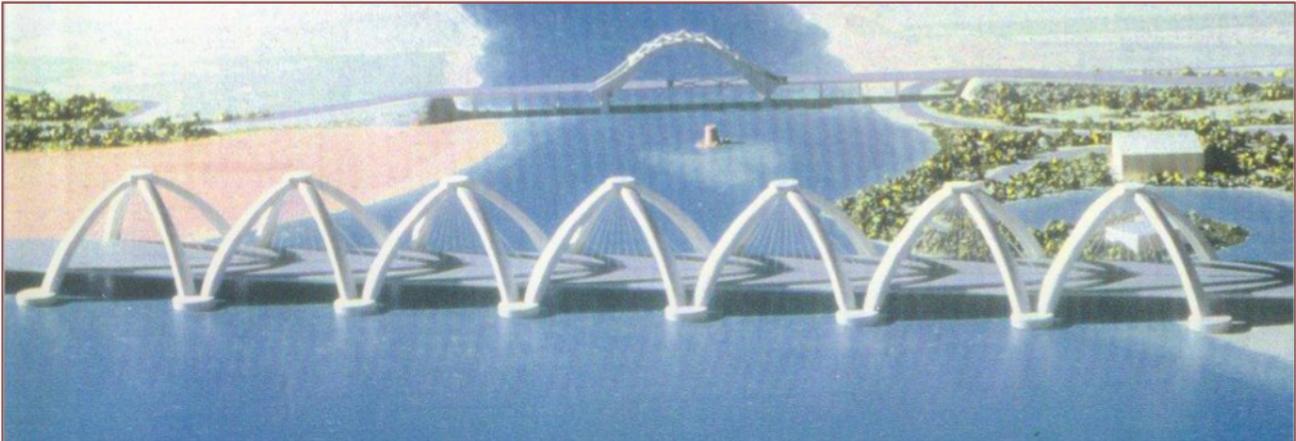


Figure 26: Model of 500m long scheme proposal

The very dry marine environment creates very aggressive material conditions with concrete being more commonly adopted but requiring additional measures to ensure durability.

We derived a concept using four parabolic arched ribs which would then support the deck using vertical stays hanging from a central 'crown'.

With seven successive arches, the waterway could be crossed, and an odd number were chosen as this is normally more aesthetically attractive.

Although we prepared drawings for the whole scheme and general arrangements of the bridge, it is normal practice in the Middle East to produce models for study by the client and government representatives.

The brief specified a 1:2000 scale model for the highway scheme, which converted to a table top measuring 4 x 1.5 metres (the same width and 50% longer than a standard table-tennis table).

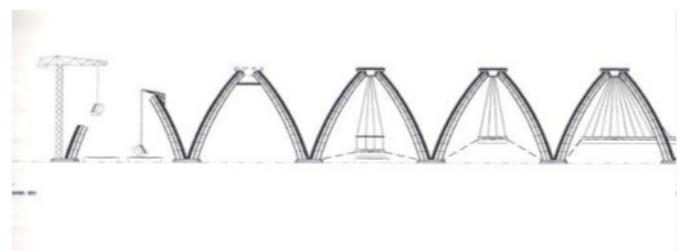
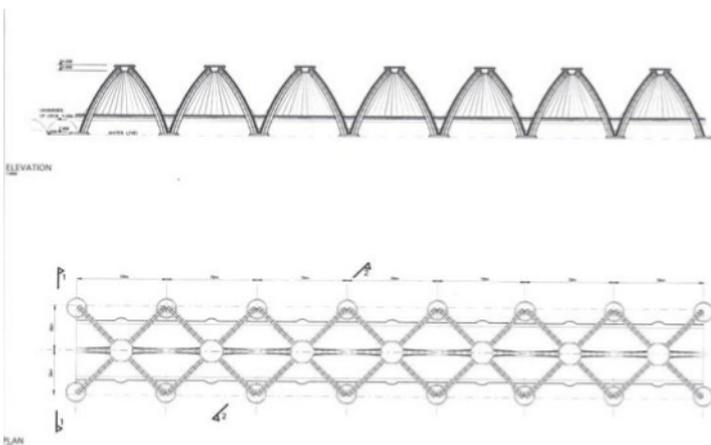
In the centre of the table, the bridge appeared at 250mm in length, (Figure 26) but we felt this did not do it justice, so we made a late decision to also make a 1:350 scale model of half of the bridge.

This comprised three and a half 'humps', but our model makers suggested using a mirror at one end to 'double' its appearance.

As the images and drawings in Figures 27 – 32 show, this was quite effective and also made the model much more manageable to handle. This was necessary as I had to carry the model as hand luggage from London to Abu Dhabi to meet the submission date.

It is an under-statement to say that the journey was quite eventful, especially when the model went through the airport scanner and the wiring on the model lighting was visible through the plastic moulded parts.

I was lucky – this was a much more innocent age of travel. If this happened now the model would have to have gone air-freight instead of being upgraded to business class just 30 minutes before take-off!



↑ Figure 27: Indicative Construction Sequence

← Figure 28: General Plan and Elevation

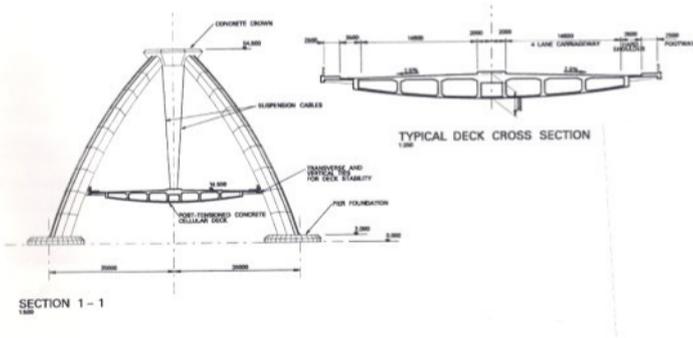


Figure 29: Deck Cross-section and Section 1-1

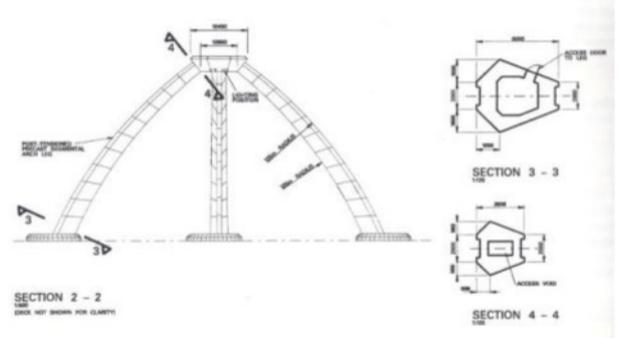


Figure 30: Arch Details and Sections

Learning Points

Competition proposals are not always built, but they offer the opportunity to push your imagination and technical capabilities. I have found that a team's joint skills and experience often combine to produce even better solutions than were first conceived.

Design is always an iterative process but once the end solution is reached it is usually apparent whether it satisfies all the requirements and constraints. Sometimes there is pressure to compromise, but getting the best result is essential and quality will last.

We have to remember that many of our schemes will be permanent and need to fit well into the environment, ideally adding value and benefit.

At this time computer aided graphics were still in their infancy and drawings still took time to prepare. Also we could only afford to build a single model of the preferred scheme, so we always sought to identify viable and what we considered the most appropriate option based on all the requirements.

One of my directors advised that we should never offer too many solutions for client consideration as this might lead to the selection of a less suitable scheme.

More than 25 years on, with the ease of exploring several layouts using versatile computer graphics, the use of physical models has much reduced and we have lost some very skilled model makers too.

This scheme would certainly have been interesting and challenging to build but it was a little ahead of its time in terms of the client's commitment.

The Sheikh Zayed Bridge it became was eventually built in 2010 to another design using the shapes of sand-dunes as inspiration, slightly different from our camel 'humps'!

If it had been realised I think our proposal would have achieved the landmark we were looking for.



Figure 31: Detailed Model of cable-stay support



Figure 32: Model cross-section

Kuala Lumpur 'STAR' Light Rail Transit, Malaysia

The Phase 2 Contract for this project was planned to serve Kuala Lumpur city centre and extend the mass transit route to the north and south, specifically to connect with the main stadium built for the 1998 Commonwealth Games at Bukit Jalil, a southern suburb in the rapidly developing area.

The works had been awarded to Taylor Woodrow International on a Design and Build basis to be delivered in about 3 years including all the design preparation.

This hard deadline could not be moved and so the focus on programme, as well as practical solutions to some major obstacles, put huge pressure on the whole design and construction team.

Co-ordination of all the essential multi-disciplinary inputs and delivery of the design in sufficient time to allow for advance ordering of specialist items, such as bearings, also became a huge challenge.

A railway scheme is one of the most demanding transportation systems governed by the service timetable and efficient train operation.

Engineering solutions must resolve many different requirements and the KL STAR LRT was complicated by many existing urban and environmental constraints coupled with complex geology.

I was involved in resolving some of these interfaces, coordinating technical disciplines and actively monitoring the progressive approvals process as the design developed from concept to 'issue for construction' stage.

This task was illustrated at the Northern Headshunt, a turn-around situated on an elevated concrete viaduct adjacent to Sentul Timur Station, allowing trains to reverse direction at the end of the line.



Figure 33: Segmental Viaduct under construction

Train operation required the elevated station to be on straight and level track, the viaduct designers desired a thermal movement joint next to the station and the track designers needed a switch (set of points between the twin tracks) at the viaduct joint location.

The headshunt had to be longer than a six-carriage train of course, but land was limited. The geotechnical team reported that there was an underground 'overhanging cliff' in the limestone directly below the foundations.

Some piles were relatively short, others might be 60 to 80m long, but if they ended up on the edge of the cliff, stability could be compromised. There was limited latitude to make changes in terms of alignment or station position.

To resolve the conflicting requirements, adjustments to the design of each technical element required re-work which individual teams were reluctant to undertake as this affected work and resources needed for other equally critical work packages.

Each discipline had to make allowances – some less willingly than others – but in the end the best technical solution was found and work moved on to the next urgent deadline.

Another prime feature of many transport schemes is their linear nature and intermittent means of site access. This scheme was no different and there was an additional need to limit local disruption to traffic in the city or on major routes.

To overcome this, the decision was made to use post-tensioned segmental construction on several viaducts built using the balanced cantilever method.

Every precast segment was specifically made to suit its intended location, match-cast in the factory against its adjacent units.

It is then cured, stored and delivered to site in the right sequence as it is installed using a launching gantry. The erection process had to be carefully planned and monitored at all stages to guarantee stability, not least ensuring that the cantilevers remained balanced at all times.

This was an occasion when the Contractor's experience combined with the designer's own analysis produced an efficient and rapid installation process.

One of the limitations was the requirement to control the out-of-balance moment on the piers as each segment was successively added.



Figure 34: Precast Segment at factory



Figure 35: Segmental Viaduct built along river corridor

As temporary propping would need extra foundations, defeating the concept of the balanced system, temporary support falsework needed to be strongly clamped to the opposite sides of the slender, but heavily reinforced, concrete piers but without damaging the surface finish.

The Contractor proposed using vehicle brake lining sheets gripping to the concrete with a guaranteed minimum friction of 40%.

The calculated moment of resistance could then be generated by adding as much clamping friction force as necessary across the pier. It was a neat and simple method giving us a reliable means of ensuring stability.

Learning Points

Maintaining team spirit was essential to morale and successful delivery of the scheme was a testament to the dedication of everyone involved.

The deadlines and pressure necessitated the mobilisation of a very large team and to get the necessary resource, work was shared across several offices in different time zones.

At the time we had some of the benefits of modern, fast communications, but the key was sharing work to the extent that the design was progressing continuously 24 hours per day.

I personally learnt how important it was to plan, coordinate and monitor the works of different disciplines so that the end solution met all of the requirements.

For a linear transport scheme it was essential to ensure that any major obstacle or constraint is identified as early as possible so that it does not become a potential cause of delay.

On 27 October 2006, a six-coach LRT train which came in from Ampang overshot the end of the elevated tracks at the end of this station, resulting in the front half of the first coach dangling in the air about 25 m above the ground.

Only a lone driver was on board when the incident took place. Only Sentul Timur endured service disruption for 20 minutes that day.



Figure 36: Kuala Lumpur LRT – Train overruns the headshunt at Sentul Timur Station

Source – Wikipedia

Also design packages needed to be delivered on programme but there was a complication. The Contractor was always looking for more efficient construction methodologies and until the concrete was cast or steelwork placed he reserved the right to request changes.

This was very disruptive if the design had to be re-visited to check for an alternative set of conditions during construction, especially when working on a fixed fee basis.

Value Engineering is important but needs to be undertaken sufficiently early in the programme to be effective.

Bangkok Elevated Road and Train System (BERTS), Thailand

The city of Bangkok is one of the largest but most congested cities in the world. A fragmented highway network and a lack of reliable public transport resulted in notorious traffic delays.

Gordon Wu, a Hong Kong based developer, while sitting in a traffic jam beside a railway, conceived an ambitious plan to utilise primary transport corridors adjacent to existing railway routes running North-South and East-West to provide improvements over 60km in length.

This was no ordinary scheme. The project would be self-financing generating revenue from expressway tolls, mass transit rail fares and rent on prime development space.

To obtain concession access to the land required, which was owned by the State Railway of Thailand (SRT), the developer offered to fully upgrade the existing sections of rail track. The land corridor was typically between 50 and 100m wide.

From the start this scheme was planned to be elevated over its whole length as this solved the existing use of at-grade crossings between the SRT and highway network – a major source of traffic delay.

Also extra height allowed the scheme to cross over major obstacles such as klongs (canals and waterways), major highways and other urban infrastructure.

A schematic model of the proposals for the North-South corridor section is shown in Figure 37. This shows the key elements as follows:

- Twin concrete box sections each supporting a 3-lane Expressway on the top flange with two track Mass Transit lines inside the box itself.

- A central viaduct between the boxes supporting two or three SRT lines.
- Property and retail development built below each box at ground level.
- Local road network providing access to the property as well as individual stations for the Mass Transit and SRT.

The East-West section was narrower, necessitating a slightly different layout as shown in the model in Figure 38. The Expressway occupies the top level, SRT and Mass Transit tracks share the middle level and local roads are at ground level.

Another major technical challenge was going to be the three-way multi-modal interchange between the North-South and East-West arms at the 'Chitralada Triangle' near Dusit.

With the three transport modes – Expressway, SRT and Mass Transit – each needing two levels, a six level complex junction was envisaged with a height of 50-60 metres.

Some concepts seemed to resemble a roller-coaster, and much work was needed to get a functional layout.

A model of an early concept is shown in Figure 39. This shows the spiral ramps in the centre allowing highway traffic to travel up or down between ground level and the top levels.

At a 4% grade, these ramps were at least 1.5km long eventually threading their way out between all the structural supports.



Figure 37: Model of primary structure on the North-South Route



Figure 38: Model of primary structure on the East-West Route

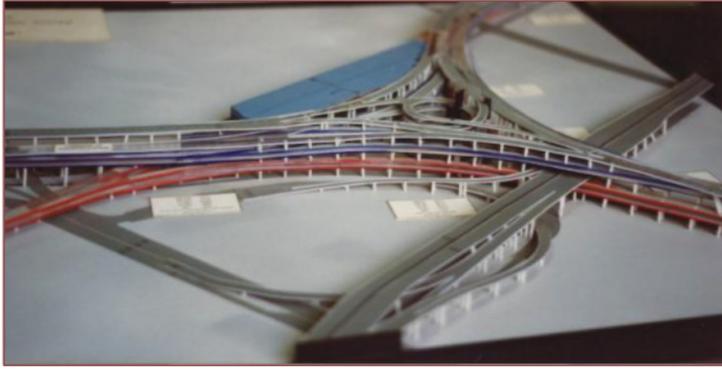


Figure 39: Model of the 6 storey interchange at Chitralada where the North-South and East-West routes meet

As with many major transport schemes, they are linear projects and access is often restricted to specific points along the route.

The primary challenge was to develop the scheme for efficient and repetitive construction and installation of the box sections.

On the North-South section, the typical box module was to be 45m long, 8m high and 14m wide, with a projected weight of 1200 – 1500 tonnes each.

The module length was adjusted where needed to coordinate pier positions with existing site constraints.

The strategy was that the boxes would be precast in a pre-fabrication works and then transported using SPMTs to the work front before installation using a bespoke launching girder.

Over the 40km long North-South section this would entail the construction of about 2000 box sections – a huge undertaking.

Foundations and pier substructures were built in advance alongside or over the operational SRT lines as shown in Figures 40 and 41.

At the same time the first trial boxes were constructed, initially insitu, to test the practicality and logistics of the chosen layout – Figure 42.

It was evident that each unit would take several weeks to build by this method, so precasting in multiple casting bays in a purpose built factory yard would be necessary, employing huge resources and material.

At this point the project had been in progress from concept to on-going construction over about 7 years.

The Developer had already invested about US\$500 million (less than 20% of the projected investment) when suddenly the financial crisis hit the Asian ‘Tiger Economy’.

It was 1997 and the project was quickly suspended. Many kilometres of supports had already been built.

In due course many of these supports were demolished to make way for subsequent transport schemes in the same corridor while other sections were left standing as a monument to the commitment of the Developer – Figure 43.



Figure 40: Viaduct supports on the North-South route



Figure 41: Viaduct supports on the East-West route



Figure 42: Standard Box section during construction



Figure 43: Remnants of scheme after cancellation

Learning Points

BERTS was an awe-inspiring and hugely ambitious scheme. The Developer was wholly focussed on finding feasible and practical solutions.

To facilitate this, a multi-disciplinary design team over 200 strong was set up in a dedicated London office owned by the Developer.

The office was shared with the Developer's own planning and contracts team. This co-location allowed for rapid decision making and close co-operation between the various teams.

There were other teams located in Thailand and Hong Kong as well, monitoring progress and interfacing with the site works.

Many route sections could be planned with a linear and repetitive solution, but it was the non-standard obstacles that presented particular challenges.

Construction contracts for foundations and substructures were awarded progressively starting with standard sections between stations and expressway interchanges.

At the same time it was essential to prioritise where the critical conflicts might arise, so enough time could be assigned to resolve these technical challenges with non-standard layouts.

The focus of the team was emphasised by the fact that construction was already in progress and that the final layouts would be sub-contracted for construction according to the programme.

The linear nature of these schemes meant that we could not have any physical 'gaps' as the superstructure would need to provide a continuous route during delivery of the pre-fabricated box sections to the work front.

The Chitralada Interchange was key, and it had to be workable. As it happened we never actually completed this package before the works were suspended.

When work was suspended the team was quickly disbanded to save costs which left us with a sense of disappointment after so much hard work, especially with the evidence of real progress being reported back from the site.

There was still a long way to go, but the majority of the technical issues had workable solutions.

Maybe in the end it was 'a bridge too far'!

1997 Integral Bridges Tour of North America

In 1989 the publication of 'A Survey of 200 Highway Bridges' by Wallbank ⁽⁵⁾ marked a milestone in changing the UK's approach to bridge design and maintenance strategy.

The report confirmed the widespread poor performance of many bridges. Six main causes of deterioration were investigated:

- chloride attack
- alkali silica reaction (ASR)
- carbonation
- frost action
- sulfate attack and
- high alumina cement.

The results showed that the most serious and widespread form of deterioration was reinforcement corrosion arising from contamination by chlorides from de-icing salts typically penetrating through failed movement joints and affecting abutments, pier supports, bearings and parapet upstands.

Recommendations for improved construction and maintenance were proposed, primarily the use of integral construction, encouraging structural continuity and eliminating the use of movement joints and bearings where appropriate.

In 1995, UK government agencies issued new requirements requiring all designers to adopt these recommendations.

Elsewhere, other national or state agencies had already recognised the benefits of integral construction. Innovative solutions have developed using a mixture of testing, experience and analytical methods.

The UK guidance applied to all bridges less than 60m in length and with skews less than 30°.

My interest in concrete bridges included supporting the Concrete Bridge Development Group, a UK trade association.

The theme of their annual conference in 1996 concerned durability and I offered a paper based on my interest in structural performance and the use of integral construction based on my experience designing bridges for the M40 Motorway, as well as bridges elsewhere ⁽⁶⁾.

The CBDG, with the support of the Department for Trade and Industry, organised a study tour in North America to gather experience on the performance of integral bridges in various states. I was honoured to be invited to take part in the 10 day tour.

A party of six engineers, led by Howard Taylor, set off in August 1997 to visit state departments in Ohio, Tennessee, Illinois, Missouri, Ontario, Washington State and California.

We split into two groups and I was in the team with Howard and Bruce Nicholson visiting the Mid-West States to discuss with engineers from consultants, state departments and research organisations their experiences with the design, construction and maintenance of many different forms of integral bridge.

It was a fascinating and instructive tour.

We learnt about the methods of analysis, with many rules of thumb based on experience rather than extensive computer modelling, collected details of how different construction details were used, and were given feedback on successful and less successful solutions.



Figure 44: Typical bridge in North America



Figure 45: Damaged bridge with seized bearings

In Tennessee we visited some bridges which were much longer than the 60m UK threshold and they were performing well without movement joints and bearings.

We found that nearly all state transportation departments were prepared to experiment, partly because they were acting as Client, Engineer, Contractor and Maintenance Authority all rolled into one organisation.

There was a no-blame culture and minimal litigation as they encouraged innovation and research into better understanding of structural behaviour and methods of construction.

The Tennessee engineers really wanted to push the technical boundaries and they had a slogan to focus their approach which was: "NO JOINT IS A GOOD JOINT". Some of the longest bridges they had successfully built were nearly 300m long to prove the point, and one bridge, with just abutment movement joints but no pier bearings, was 843m long.

It was exhibiting a few problems, with some temperature induced cracking, but this was being monitored at the time.

On our return to the UK we quickly produced a tour report ⁽⁷⁾ of our findings and made recommendations to help engineers on how to select and analyse different structural forms.

In assisting my own colleagues, I prepared a manual of more detailed guidance, some of which I would like to share.

Integral Bridge Selection Guidance

Although there are many different types of integral arrangement, my approach is to categorise them into three main types as follows:

- Short-span portal frame with tall abutments (including box structures) – Type R (Figure 46)
- Long, multi-span deck with low height bankseats – Type B (Figure 47)
- Semi-integral construction which can have a combination of features (eg bearings) and will accommodate small movements – Type S (Figure 48).



Figure 46: Portal Bridge with Closed Abutments – Type R

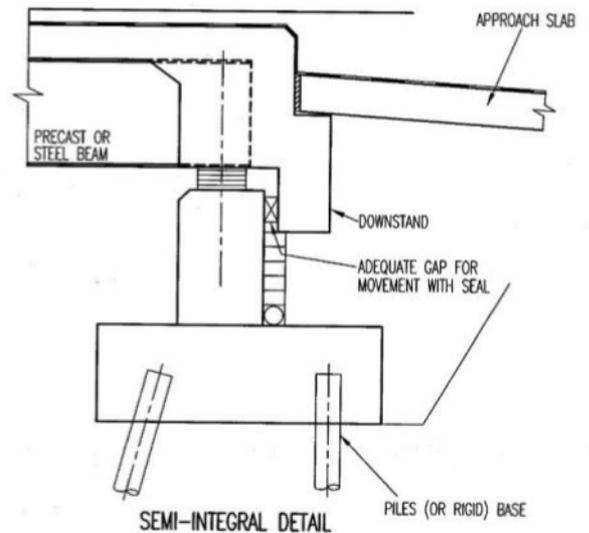


Figure 48: Semi-integral Bridge Abutment – Type S

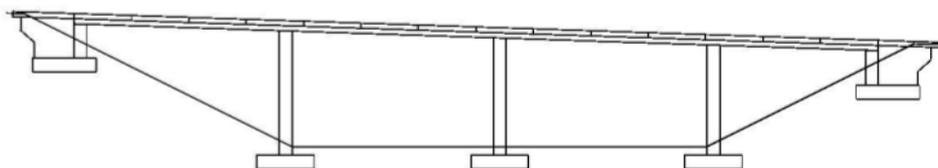


Figure 47: Integral Bridges – Multi-span Bridge with Open Spans and Bankseats – Type B

To assist my colleagues I prepared a design manual with guidance on how to approach the design and analysis. Figure 49, shown below, was used to quickly identify the potential layout for combinations of length and height.

The aim of the diagram is to allow designers to quickly assess, for example, whether a rigid frame is appropriate. It will be seen that such solutions are unlikely to be feasible if the deck length exceeds about 45m.

Note, however, that the limits could be adjusted by 10 – 20% depending on the form of deck (steel v concrete), abutment rigidity (pinned v fixed), ground conditions and applied loading.

Derivation of the limiting lengths for specified types of deck construction were derived using typical expansion coefficients, overall temperature range and limiting abutment movement to a range of 20mm.

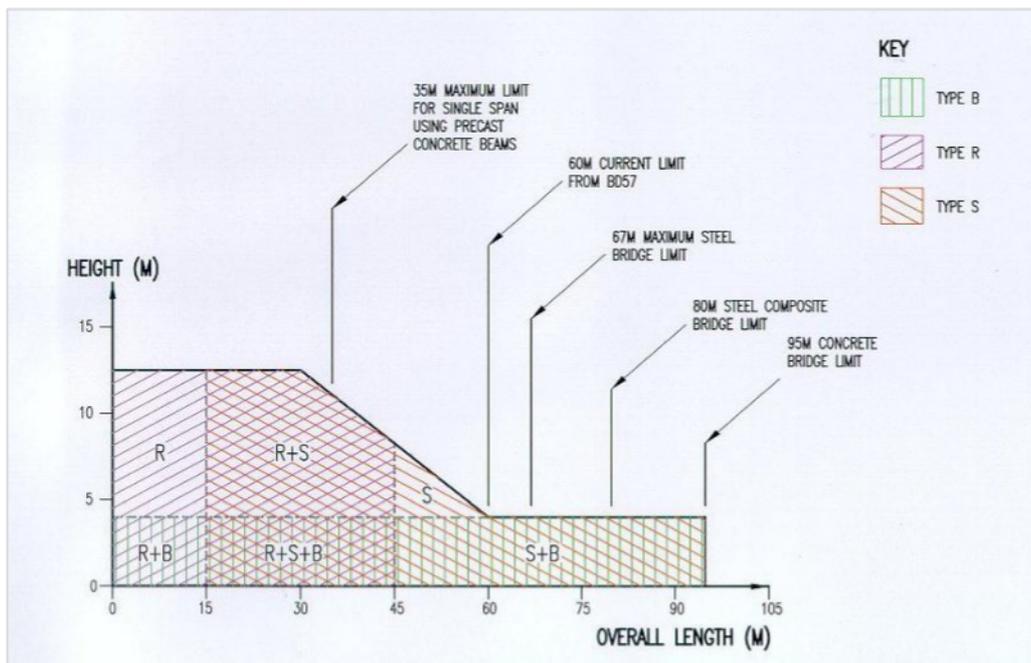
Learning Points

My greater appreciation of how integral bridges perform probably crystallised many of the things I had learnt in my career up until that stage.

It is clear now that good bridge design must consider the overall durability, constructability, performance and whole life cost without sacrificing quality.

I have worked with many very talented people and I have learnt from them that every aspect of a design needs to be carefully planned to achieve the optimum result.

↓Figure 49: Selection of Bridge Type based on Length and Height



M42 Blythe Park Bridge, Solihull, W. Midlands

I have always been interested in the whole of the delivery process for a scheme.

Early on in my career I asked an experienced colleague, whose drawings were a work of art in terms of design quality, how a particular bridge would be built given the need for extensive temporary works.

They replied that that was the contractor’s job! I found this a rather surprising way to approach the overall problem-solving and successful construction of a scheme. Now designers are required to consider the methods of construction, and maintenance, in terms of safety and performance.

They also consider potential future changes of use and eventual demolition when materials might be re-used sustainably.

Blythe Valley Park is a business park development, on the outskirts of Birmingham, beside the M42 Motorway and new access needed to be built as part of the new highway layout.

The bridge crossed over a deep cutting in which there was a dual 3-lane motorway and slip-roads to an adjacent junction. The minimum overall length needed to be about 75 metres.

The bridge scheme was interesting in that planning permission had been granted on the concept of providing an arch bridge solution to act as a landmark for the business park.

An arch fitted the deep cutting of the motorway, with a long clear span over carriageway and slip roads. The Highways Agency, responsible for the motorway, stipulated that any closure of the motorway would be restricted, with no extended lane possessions. Essentially one short closure would be permitted.

An arch was an efficient solution but a conventional arch with thrust foundations in the cutting side slopes was incompatible with fast construction.

Space was available in the land adjacent to the motorway which was suitable for pre-fabrication and using a tied steel arch scheme, installation of the whole superstructure in a single operation was developed.

The estimated total weight of the bridge superstructure would be 1400 tonnes. Half of this load, supported at one end, required substantial temporary work on a mobile transporter.

When I worked on the Foyle Bridge, self-propelled multi-wheel transporters (SPMT) were used to move the 1000 tonne sections off the sea transport barge onto the site haul roads.

These transporters are used widely in the industrial sector, to move major heavy loads but are not so common in civil engineering.

Their benefit is that the wheel loadings will not damage highway pavements, but for this project to support 700 tonnes plus temporary works, 120 wheels would be needed.

The trailer was about 14m long and 9m wide but obviously it could not travel up or down the 1 in 2 side slopes of the motorway.

The installation solution, shown diagrammatically in Figure 50, involved positioning the trailer between the permanent bridge support columns (that would subsequently become part of the abutment) and excavating back into the side slopes using bored piles to create what we termed as the 'garage' to 'park' the trailer centrally under the 'launch' end of the arch.

The tolerances were quite small so we needed specific data on the trailer specifications early in the design process.

In discussion with the motorway authority it was agreed that a maximum of 12 hours would be available for a full closure of the M42, which would be at night during a weekend.

The M42 carried about 80,000 vehicles a day so it was deemed critical that re-opening was guaranteed and if necessary the bridge could be 'parked' in a safe position.

This requirement was based on the disruption caused by an earlier incident when a SPMT became bogged down in the soft verge of a different motorway during a bridge demolition operation causing 3 days of traffic chaos.

With my team, we concentrated on the method of installation, and worked closely with the Contractor and Sub-contractor for the SPMT.

This is when the benefits of a Design and Build contract are fully employed as the combined ideas and skills of each party can be focussed efficiently on achieving the best results.

Prefabrication of the bridge away from the motorway itself offered many advantages in terms of site preparation, access, assembly of steelwork, quality of work and not least safety.

At the same time we prepared a scheme for the installation process as well as information that could be used to inform the public and local community of the proposals.

Closure of the motorway needed several months of advance notice and once agreed the Contractor was focussed on achieving this milestone date.

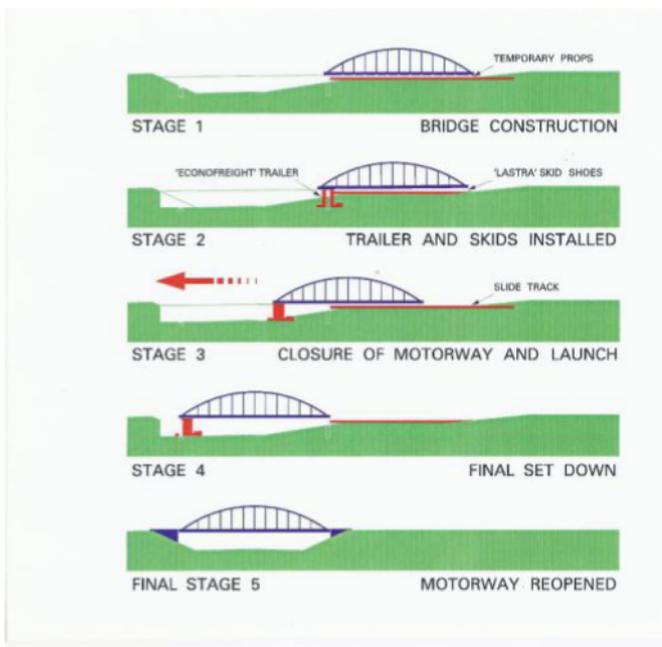


Figure 50: Schematic Construction Sequence



Figure 51: Steelwork during assembly

Eventually the weekend arrived. All of the transportation equipment, Figure 52, was assembled and to ensure that the systems were active a trial lift and short one metre move were undertaken the day before.

Although it was November, the weather was suitable. The most critical concern was the risk of high winds as we calculated that if the forecast was for anything over Gale Force 5, the operation would have to be postponed.

Stability of the temporary tower built on the SPMT had to be controlled as the highest parts of the bridge were over 25m above ground level and sensitive to wind over-turning moments.



Figure 52: Self-propelled Multi-wheel transporter with 120 wheels



Figure 53: Bridge Superstructure during

The main operation to move the bridge forward by its full length of 76 metres took only 2 hours but ancillary operations, including mobilisation, setting the bridge onto its permanent bearings and removal of temporary works increased the overall time to about 8 hours, well within the closure period and traffic was allowed back onto the motorway at dawn, see Figures 53 and 54.

The final result was successful and very satisfying. The aim to have a simple, uncluttered structural appearance with smooth sided, free-standing arches and no cross-bracing between the arch ribs was visually effective.

It has become a local landmark and the style of bridge has been mimicked elsewhere – a tribute to its visual impact although this hides its technical complexity.

Learning Points

The scheme was a very successful demonstration of the benefits of a Design and Build contract with the design team working closely with the Contractor, steel fabricator and specialist suppliers to meet the scheme requirements.

To do this, in a similar way that I had seen on previous schemes, needs a robust strategy for the construction methodology. It was even more satisfying to achieve an aesthetically appealing and high-quality result.

The project won an award from the Institution of Civil Engineers recognising this successful achievement.



Figure 54: Bridge during installation with motorway closed



Figure 55: Deck after installation over motorway



Figure 56: Blythe Park Bridge – Completed bridge



Figure 57: Elevation of complete bridge

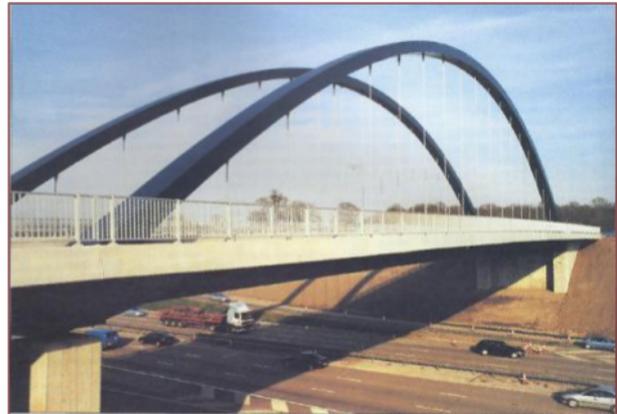


Figure 58: Completed bridge

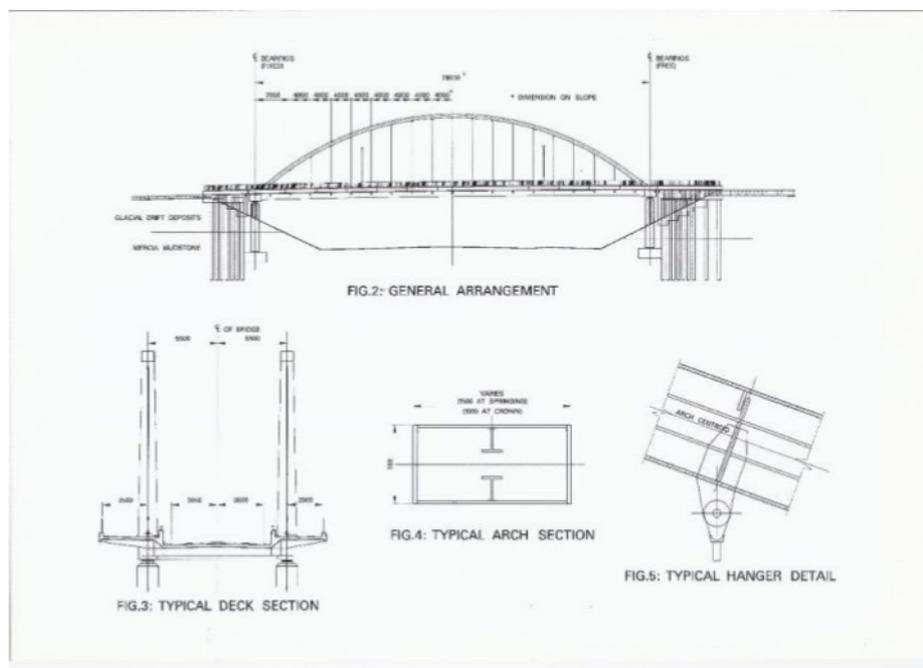


Figure 59: Structural details

CONCLUSION

In more recent years I have had the opportunity to be involved in a number of other notable bridge schemes whilst also having the responsibility of initially leading AECOM's Bridges and Structures business in Europe.

In the last six years I took the decision to move from the world's largest consultant to the smallest, now working as an independent consultant.

Some of these projects have been the most challenging and satisfying projects of my career, requiring me to draw on all of my previous experience, and with the help of colleagues, to achieve the necessary outcomes and deliverables.

Several of the more recent schemes have concerned the feasibility and implementation of long span suspension and cable-stayed crossings which always comprise technically complex features.

Several of the more significant projects have been featured in e-mosty over the past 3 years, whilst others are still in the course of construction.

Of these I consider that the Osmangazi Bridge in Turkey, the fourth longest bridge in the world built to date, to be the culmination of all my engineering practice.

After a period of six months successfully bidding for the commission as the Concessionaire's Technical Consultant, the scheme programme necessitated rapid preparation of a comprehensive project specification and tender in order to appoint an EPC sub-contractor (an Engineering, Procurement and Construction model based on FIDIC 'Silver Book' contract conditions).

The bridge crosses one of the most seismic faults in the world and specific measures were needed to ensure that the conceptual solution, especially the foundations, will cater for the potential conditions that may arise.

More detailed articles can be found in previous issues of e-mosty describing its design, construction, operation and maintenance, please see links on the next page.

One interesting historical note was that originally the bridge was planned to have the second longest span in the world (at that time) with a clearance of 1700m.

This was partly to span the main channel, but also to make a bold statement for the ambitions of the Republic of Turkey as part of its rapid economic development.

While preparing the specification for the EPC tender, and with reference to earlier site investigations, it became apparent that there would be benefits in shortening the main span to 1550m so the tower foundations were not positioned on 'steeper' sub-sea slopes, which is not advisable in a seismic zone, even though construction would then take place in 50 – 60 metres of water.

Also, the southern end of the bridge would be moved to reduce the likelihood of the bridge actually being built directly on potential fault lines associated with the North Anatolian fault.

This illustrates that every project must be optimised to suit the specific constraints for which it is designed and built, despite our natural desire to extend the boundaries of achievement.

Ultimately, I have enjoyed working with many talented and dedicated colleagues, clients and contractors.

Also, I hope that I have helped and inspired many of my trainees with some of the experience which I have described in this article.

It has been equally rewarding to see their own successful achievements taking place elsewhere – enhancing the places in which they are now working throughout the world.

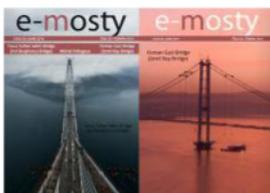


*Figure 60: Overall View of the Osmangazi Bridge
Photo Credit: Fatih Zeybek, OTOYOL YATIRIM ve İŞLETME*

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Links to projects already featured in e-mosty in which I have participated:



*The Osmangazi Bridge
Design and Construction*



Operation and Maintenance



Vessels and Equipment for its Construction



The Queensferry Crossing, UK



The River Irwell Bridge, UK

INTERVIEW WITH RICHARD COOKE

Derya Thompson

I would like to thank you first for being a role model and mentor for many of us in the civil engineering arena. Your contribution to our ICE training and continued professional development has been invaluable.

In my case, I am grateful that your support never stopped and continues despite the distance and time zone difference.

I will start by asking the obvious “Why bridges?” You mention that while studying Engineering Science at Oxford University you knew that you wanted to be a structural engineer. What made you choose Bridges? How did Bridges become your passion?

When I was growing up we had many holidays in South Wales, travelling there from near London. It was a long, slow 6-hour journey as some of the intermediate sections of the M4 Motorway were still being built (it was eventually finished in 1971).

The highlight was always the crossing of the Severn Bridge which was completed in 1966. One year we took a wrong turn and followed the old A40 road via Gloucester instead, completely missing the Severn.

The sense of disappointment made a huge impression on me and every time I now use the Second Severn Crossing, or occasionally the original bridge, I always remember that journey and must have been inspired by the sense crossing such a wide estuary. My mother was never allowed to forget it either as she was driving the car!

Additionally I had always played with well-known construction toys, but specific interest probably started when I was required to do a school project and I chose ‘Bridges’ as my subject. My supervising teacher pointed out one or two additional types which I had not considered and this spurred my interest to find out more.

Later during a careers presentation, an engineer described how new graduates would be given a whole bridge to design as part of their training. This was a tangible challenge even though I was still unaware of the precise technical skills I would need to learn to achieve this. Civil Engineering was an obvious choice of university degree.

Did you have a mentor or someone who guided and sponsored you early in your career? I was lucky to have you as my Delegated Engineer, but it took me years to truly appreciate how influential you were in training and developing young bridge engineers.

I have had many mentors who provided invaluable advice in different ways. Probably the three with the greatest influence early on were Angus Low, Peter Brooke and Duncan Wilkinson. Between them I gained essential technical and practical skills needed to analyse and design many types of structure.

They never hesitated to share their experience to help me focus on how to solve a problem efficiently and effectively. They also broadened my outlook as I learnt to manage the work of colleagues.

Was innovation always a driver for you? Together with a few engineers, you had a personal contribution in the revival of integral bridges. Would you consider those efforts as the start of the sustainable design era for highway bridges?

During my time at Arup I experienced their deeply ingrained philosophy of problem solving and quality applied to all projects. Innovation becomes an important element of many schemes if conventional methods appear clumsy or inefficient.

Our profession should always aim to find the 'best' solution, not just the 'basic' or utilitarian solution. Now we are much more aware of the acute need to be sustainable, use materials efficiently and to learn from past experience.

Integral bridges are one of the fundamental ways to achieve these objectives coupled with the latest research and technology.

They have of course been in existence for hundreds of years – most arches are integral – but until the 1970s many conventional bridge designs would still be undertaken manually by simplifying the structural articulation (introducing joints) and dividing the bridge into component parts – abutments, piers and superstructures.

In the UK, at least, new guidance was needed, necessitating more complex analysis methods so that more durable and efficient structures could be built.

I was fortunate to be directly involved in promoting these structures and gathering existing experience from elsewhere in the world.

Was your transformation from the design of modest highway bridges to the long-span complex structures, such as cable stayed bridges and suspension bridges, an easy transition? How did you excel in the latter with the same expertise?

Although I had acquired some long-span bridge experience progressively through my career, my responsibility to win major projects when I joined AECOM necessitated some rapid personal development in this field.

Fortunately I had colleagues like Charles Cocksedge, Mark Bulmer, Kandiah Kuhendran, Simon James and Steve Baron who were able to share their extensive knowledge in the design, maintenance and repair of many existing long-span bridges.

This allowed me to improve my own capability sufficiently to secure key commissions for the Izmit Bay Bridge, the tender design for the Third Bosphorus Bridge (unfortunately unsuccessful) and the independent design check of the Queensferry Crossing.

The preparation of the design and tender specification for the Izmit Bay Bridge, followed by the assessment of tenderers' detailed proposals, then presented the opportunity to be wholly involved in this fascinating and rewarding field.

As well as designing major bridges and complex structures, you studied and analyzed many existing bridges, of different grandeur, form and era.

Has the knowledge gained by those assessments made you a better designer?

I certainly hope so! Bridge assessment provides us with an essential insight into the skills, and sometimes the practical errors, of our predecessors.

From a study of existing condition, we can learn about the performance of materials, how they may be deteriorating and the impact of increasingly heavy vehicles.

Often original design drawings or calculations may be no longer available so additional investigations are needed to verify dimensions, material strengths or reinforcement content.

I think the most useful feedback arises from finding details that are difficult to inspect, verify or maintain.

It is important that we don't make the same errors when designing a new structure and it should always be possible to replace any critical elements that may not have the same design life expectations as the structure as whole.

Now we plan new schemes much more rigorously with specific proposals for future inspection, maintenance and eventual demolition.

With the latest BIM procedures, clients are getting better at recording information for future reference too.

Who has most influenced your creativity, in terms of structural form and visual appearance?

Bill Symth, an Arup director, probably had the greatest impact in the course of advising and reviewing proposals for many of my projects.

He was a recognised expert and had written guidance standards on bridge aesthetics for national bridge owners.

He impressed me with the need to appreciate overall proportions combined with the importance of details, finishes and landscaping which contribute to the total appearance.

His constructive critique invariably led to a better scheme.

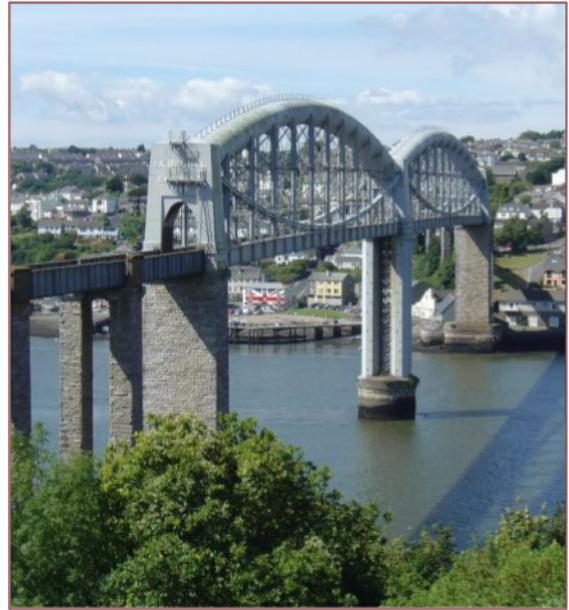
What is your favourite historic bridge, and why?

The Royal Albert Bridge at Saltash near Plymouth designed by Isambard Kingdom Brunel.

It is an outstanding solution using lenticular wrought iron tubular arches with self-anchored suspension chains so that each span can be simply supported.

The ingenuity required for the bridge to span a deep water channel at high level and to carry heavy locomotives speaks for itself and the aesthetics express its functionality without the need for excess embellishment.

It may have never been repeated but is instantly recognisable as an exceptional bridge.



Which bridge or other structure most influenced your early career, is it still an influence?

I spent the first two years of my career after university working on the independent check of the Foyle Bridge, so when I had the opportunity to work on the design of the Kylesku Bridge in Scotland this marked a step change gaining experience in the structural analysis and design of a major concrete bridge.

The bridge was a major challenge for the whole team given its remote location. Only last year I managed to visit the bridge itself for the first time and even though I knew much about how it had been built I was still impressed with the aesthetics and quality of design.

What is the most personally satisfying project you have worked on? Why?

Many projects take several years to realise from concept to completion, and I have not always been involved with the whole process from start to finish as new assignments arose in the course of my work.

For that reason, the Blythe Park Bridge scheme gives me the most satisfaction as I was able to influence the concept, guide the design, develop the installation method and finally see the bridge installed successfully and completed.

It was part of the access highways serving the new office in which I later worked so I had a vested interest in ensuring that it would be successful as I would then be crossing it most days on my way home from the office.

Would you say some of your studies became the disruptors for the highway bridges in the UK? What would your advice be to young engineers for not just staying relevant but leading the new technologies in the design, delivery and construction of the new bridges?

Competent design requires a sound knowledge of physics and technology. Design codes and specifications are adopted to achieve consistency but every problem has features or constraints that necessitate some lateral thinking in order to get the most appropriate result. The design of continuous bridges for mining subsidence movement certainly went against industry convention at the time.

We had many tense meetings with the client in order to persuade them that our proposals were the best approach, and eventually our conviction was upheld. I have always been passionate in trying to get to the most suitable solution and adopting innovative methods to achieve this.

Good design is rarely achieved by taking the easiest approach and it is important to undertake some research into each potential solution to ensure it meets the project requirements.

Your global experience in the design and construction of the major infrastructure projects is unique. Can you comment on the change in the roles and responsibilities in these projects over your career? How did you adapt so quickly and competently to the new roles resulting from these alternative delivery methods?

Early in my career, most schemes were delivered by a traditional sequence of design, tender, and construction using consultancy scale fees for each stage. Construction works were normally supervised by the Designer's Representative acting on behalf of the Client.

Later, Design and Build Contracts started to dominate the procurement process and consultants were normally employed by the chosen Contractor to finalise the scheme design.

The bidding environment became much more competitive as most projects had to be delivered for fixed fees, which were much lower than the scale percentage fees typically used for traditional contracts.

For Contractors, the D&B contracts were equally challenging as Clients demanded fixed price tenders and passed major risks onto the Contractor, particularly relating to them taking responsibility for unknown ground conditions.

I quickly learned that on D&B schemes the programme is key, and Contractors need design information at the right time to plan their methods, prepare temporary works and pre-order materials.

When leading teams, it is essential to explain to all those concerned that delivery of design packages on the programmed dates is sacrosanct. Maintaining good relationships and an open dialogue, with regular monitoring, is also paramount.

Whereas at the start of my career work could often be packaged into sections, now every part of the delivery process needs inputs from multiple disciplines to ensure the design is suitably co-ordinated. This takes planning and continuous monitoring.

I remember over-running a delivery deadline once and receiving an email 5 minutes after midnight inquiring why it was late. In these situations, even in the early hours of a Saturday morning, I resolved to ensure that this would not happen again.

What do you see has been your most significant skill?

Solving an analytical problem and seeing the most efficient method of finding the solution whilst using a minimum of excessive calculation.

A computer analysis can produce masses of output, but I have found myself able to focus on key outputs to determine if the results were meaningful and realistic and at the same time checking that the input data matched the problem.

One of my first mentors, Angus Low, could solve a problem in three lines of calculation which might normally need three pages of analysis – this was an inspiration.

What are your plans in making yourself and your knowledge available to young bridge engineers and next generations in the engineering field?

One of my current commitments is providing peer reviews for structural proposals for the Lower Thames Crossing, a new motorway planned east of London.

Several options are being assessed for each bridge and as part of the scheme development I have offered advice to the designers, particularly on the concept layouts for integral bridges.

I hope to pass on my experience to those who are engaged in the detailed design as the scheme progresses.

What would you like to be remembered for as your greatest achievement or contribution to bridge engineering over your impressive career?

Although I am now self-employed, I spent most of my career working in increasingly large multi-disciplinary teams and I hope that my contribution in those teams to achieve the project's objectives efficiently and successfully was recognised.

I would like to be remembered as the catalyst that helped my colleagues and clients to solve technical problems and to deliver the best scheme by adding value and ensuring quality.

Thank you very much for your time.

Richard Cooke

BA (Oxon) CEng MICE MIStructE

Richard Cooke is an independent consultant with 40 years of experience in various multi-disciplinary transportation infrastructure projects – a wide variety of bridges and structures in highway, rail and other sensitive environments, both in the UK and overseas, appointed from feasibility through to contract stages.

He has been closely involved with several high profile long span bridge projects in the UK and Europe.

For eight years Richard was AECOM's European Head of Bridges and Structures responsible for over 180 staff across the Europe region and had the responsibility for the deployment of these resources to suit project and business objectives.

Management skills include business development, preparing proposals, risk assessment, skills development and training, reviewing budgets and targets, recruitment and delivering quality solutions.

This breadth of knowledge and experience, and ability to operate strategically, has proven invaluable in the many technical and co-ordination roles that he has undertaken.

In 2013 he founded Richard Cooke Concepts Ltd and offers skills and services to the engineering industry to suit client needs.

His enthusiasm for bridge design and construction in the transportation sector is central to his complementary skills in project management, risk engineering, business development, staff training and mentoring.

Project experience includes major Long Span Bridges, Highway, High Speed Rail and Light Rail projects.



Richard has also acted as an expert witness advising on the suitability of construction details and contributed to research commissions.

He was the project manager and technical advisor for the Izmit Bay Bridge, Turkey – which was completed in 2016 with a main span of 1550m, the fourth longest built to date.

He was also project director for the independent design check of the new Queensferry Crossing over the Firth of Forth in Scotland.

Currently he is advising on the 1915 Çanakkale Bridge, also in Turkey, which will be the longest span bridge in the world when completed in 2022.

Other responsibilities have included being on the Institution of Civil Engineers' Bridge Engineering Advisory Panel, a Reviewer for ICE Professional Examinations, chairman for the BSI B525/10 Committee for Bridges and serving on the Council of the Concrete Bridge Development Group.

Professional History

Richard Cooke Concepts Ltd	2013 to present	– Owner, Structural & Civil Engineering Consultant
AECOM	2005 to 2013	– Director, European Head of Bridges & Structures
Ove Arup & Partners	1997 to 2005	– Pre-university trainee to Associate Director

Academic Training

BA (Hons) Engineering Science, Magdalen College, Oxford (1980)

Affiliations

CEng, Chartered Engineer 1985

Member of the Institution of Civil Engineers (1985)

Member of the Institution of Structural Engineers (1987)

Long Span Bridges

1915 Çanakkale Bridge, Turkey

Risk engineering advisor for the new 3.5km long suspension bridge which will have the longest span in the world of 2023m when completed. It is being built as part of the Turkish Government's latest Build, Operate and Transfer scheme, with a 16 year concession granted to a Turkish / South Korean joint venture of Daelim, Limak, SK E&C and Yapi Merkezi. Risk reviews and site visits undertaken at key stages to assist insurers and underwriters.

Izmit Bay Bridge, Turkey

Project Manager for the delivery of the Osman Gazi suspension bridge over Izmit Bay which currently has the fourth longest suspended span in the world of 1550m. The bridge is the central part of a 421km Build, Operate and Transfer scheme, the first BOT of its type in Turkey. Preparation of the tendering process to select potential contractors and design review of D&B proposals.

Rotherhithe to Canary Wharf Crossing, London

Technical review of three scheme proposals for a new pedestrian footbridge and cycleway crossing over the River Thames requiring a moveable span of at least 170m. Options considered vertical lifting and swing bridge schemes.

Queensferry Crossing, Scotland

Working for the FCBC Consortium undertaking the independent Category III Check of the new innovative cable stayed bridge over the Firth of Forth near Edinburgh which has three towers and two main spans of 650m, completed in 2017.

N25 New Ross Bypass, Ireland

Lender's Technical Advisor for the structural aspects including a 900m long extradosed concrete bridge over the River Barrow which will have the longest spans for a bridge of its type once completed.

3rd Bosphorus Bridge, Turkey

Bid Director for a tender concept design for a combined road and high speed rail suspension bridge with main span of 1400m which is the key link in the proposed 430km North Marmara Motorway.

Riga Northern Transport Corridor

Review of proposal to build a new 25km urban motorway including a 900m long cable-stayed bridge over the Duogava River with 52m shipping clearance, 4km of elevated viaduct and several grade-separated interchanges.

N25 Waterford Bypass, Ireland

Tender design for PPP scheme with 23km rural road plus links with 30 bridges including a 425m long cable stay bridge over the River Suir. Preparation of aesthetic proposals and presentation to the National Roads Authority.

Nelson Mandela Bridge, Johannesburg, South Africa

Tender design for a landmark 280m long cable-stay bridge. Bridge forms a key link for redevelopment of an urban area crossing electrified railway lines and sidings.

Abu Dhabi Third Crossing, Middle East

Preliminary proposal including an iconic 7-span 500m long cable-stayed bridge which would form the Gateway to Abu Dhabi. Scheme also involved a review of the transport network of an area of 24 square kilometres in the vicinity of the new crossing and how connections to existing roads would be achieved.

St. Petersburg Western High Speed Diameter Motorway

Advising the winning concessionaire during tender and delivery on the viability and potential risks for Stages 4 and 5 comprising a major cable-stayed bridge, an extradosed bridge and a 2km double deck truss section over a ship canal.

Technical and Expert Advisory

Lower Thames Crossing, London, UK

Peer review of structural proposals for new and modified bridges which will form part of the planned £6 billion scheme for a motorway to improve highway capacity across the River Thames, east of London.

Northern Hub Rail Improvement, Manchester

Independent reviewer, supporting Network Rail, for the proposals to construct a 90m span steel 'network' arch bridge over the River Irwell as part of a major rail improvement.

M7 Naas Newbridge Bypass Upgrade and R407 Sallins Bypass

Aesthetics Advisor for new bridge proposals, considering overall geometric layouts and finishes for concrete bridges with precast, prestressed beams and integral construction.

Ashton Arch Bridge, South Africa

Technical audit for an 8,500 tonne, 110m span concrete arch highway bridge with post-tensioned concrete deck. The bridge is built off-line, used to support the road diversion temporarily and then transversely slid into its final position before final commissioning.

Dubai Creek Bridge Review

Value engineering review of proposals for an 8km major road improvement and new iconic crossing over Dubai Creek.

Turkish Roads Privatisation

Advisor to one tender group regarding a 25-year concession to adopt 1975km of motorway and 1500 bridges. Successful proposal before strategy review by government.

Alexandra Langton Swing Bridge, Liverpool

Design scheme to modify an existing swing bridge, extending the opening span by 12m, increasing the counterweight within the back-span and involving major strengthening of the steel through-girder deck.

Chamberlain Lift Bridge, Barbados

Advice to owner/operator regarding structural faults in a lightweight composite plastic lifting bridge arising from damage caused by poor construction and workmanship.

Rotherhithe to Canary Wharf Crossing

Review of proposals for a new pedestrian and cycleway opening bridge crossing over the River Thames downstream of Tower Bridge. Three different structural solutions considered comprising a main 170m opening span and approach ramps. Two variants on swing bridges, with cable or truss supported counterweighted decks, and a third option comprising a vertical lift bridge with 90m high towers and a bow-string arch lift deck providing 60m vertical clearance when open to shipping.

Bridge Design

K60 Interchange Bridge, Johannesburg, ZA

Concept design for a landmark crossing comprising a series of 60m span steel arch bridges over a 12-lane motorway.

Jeddah Middle Ring Road, Saudi Arabia

Advice to project team for the design development of a new 80km motorway. Scheme includes over 80 bridges designed to AASHTO standards, with emphasis on precast concrete beam deck layouts to achieve rapid construction, especially over existing roads and other obstacles.

Manchester Metrolink Phase 3 Extension

Appraisal and upgrade of a large number of existing bridges to carry new tram lines, plus design of new structures as part of a £520m investment in the system.

M7M8 Portlaoise Motorway, Ireland

Project Director for the detailed design of 40 bridges needed as part of a Design and Build commission.

A494 Drome Corner to Ewloe

£48m Upgrade of 4km of dual carriageway involving the widening or replacement of 4 bridges including two rail structures.

East London Line Extension, London

Strategic Adviser and project co-ordination for a £1 billion improvement to the existing network. Scheme involves the conversion and rehabilitation of existing infrastructure up to 150 years old to current rail standards.

Channel Tunnel Rail Link, Section 2, Ebbsfleet Contract 342

Team leader for the design of 2 high level bridges carrying a road and a railway over the rail route. Each bridge crosses up to eight tracks, including four high-speed lines. Construction involves detailed plans to limit interference to existing road or rail traffic. Combined value of the two bridges is about £6 million.

Blythe Valley Business Park, Solihull, W. Midlands

Structures Team Leader for the concept and detailed design including a 78m span steel tied arch bridge weighing 1400 tonnes installed over the M42 motorway with minimum traffic disruption in a single 12 hour operation. Winner of the ICE Midlands Project Award 2001.

Dublin Outer Ring Road, Ireland

Team leader for the design of 3 bridges crossing the N7 Motorway, Royal Canal and mainline Railway for South Dublin County Council.

JFK Airport Redevelopment, New York

Project co-ordination on an extension to the British Airways Terminal and integration with a proposed light-rail system and modified road access layout. Liaison with sub-consultants and client organisations.

STAR Light Rail Transit Systems, Kuala Lumpur

Fast-track design and construct scheme for a 15km light railway. 7km of elevated viaduct constructed as either precast post-tensioned segmental concrete erected by balanced cantilever methods or steel beams with composite concrete slab. Project co-ordinator between design disciplines and with the contractor.

M6 Junction 11-16 Widening, Staffordshire

Project Engineer for the feasibility, assessment, preliminary and detailed design of 130 structures on the M6 with a total value of £65 million. Study and report on the types and appearance of sign and signal gantries for driver information and traffic control, using data obtained from world-wide sources. Bridge design proposals commended by the Royal Fine Art Commission.

Friern Bridge Retail Park, London

Scheme design for four bridges and several retaining walls adjacent to the A406 in the London Borough of Barnet. The principal structure comprised a 46m span integral bridge with steel composite deck and concrete abutments.

Bangkok Elevated Road and Train System, Thailand

Preliminary scheme design for a 60km multi-level elevated structure comprising dual three-lane tollway, mass rapid transit light rail system, Thailand State Railway tracks, retail development and associated infrastructure, drainage and geotechnical works. Major urban constraints along a narrow concession corridor including existing road crossings, rivers and existing services plus the provision of 8 tollway interchanges and 30 railway stations.

Coventry North-South Road, Phase 1

Team Leader for the design of three canal bridges and retaining walls with a structural value of £2.5 million. Highly Commended Project Award from the Institution of Civil Engineers Midlands Association.

Edirne-Kinali Motorway, Turkey

Senior Engineer designing 40 bridges on the 150km Edirne-Kinali Motorway to American AASHTO standards with seismic analysis included in the bridge detailing requirements. Emphasis on pre-cast and integral construction.

Jersey Harbour Reclamation, St Helier

Responsible for the design of an underpass, 2 bridges and subway constructed in a fill area of land reclaimed from the sea in St Helier, Jersey.

M40 Motorway, UK

Bridges design team leader for the Banbury and Gaydon sections including design of 22 bridges for the effects of potential mining subsidence and including the presentation of the proposals to the Royal Fine Art Committee which were commended.

Midlands Motorways and Trunk Roads

Bridge Engineer with principal involvement in the design of bridges on the various schemes including the M40 between Banbury and Warwick. A46 Coventry Eastern Bypass, M42/M5 Interchange and M42 motorway Water Orton Section.

Bukit Timah Expressway, Singapore

Design of 3-span reinforced concrete frame bridge and box section underpass.

Kylesku Bridge, Scotland

Detailed structural analysis of superstructure for traffic loading.

Trans Saudi Arabia Road Project

Design of a 10km section of highway as part of a 600km expressway scheme.

Bridge Assessment

Hammersmith Flyover, London

Review of proposals for monitoring, traffic restrictions, and structural repair plans for a critical segmental, post-tensioned concrete viaduct built in 1961.

East London Line Asset Inspections Phase 1

Project Director for the inspection of 235 structures to create base condition records prior to commissioning on behalf of London Overground, part of Transport for London.

Area 9 Maintenance Area Contract, Midlands

Support to Amey over successive 5 year frameworks for structures assessment, maintenance and repair.

Victoria Station

Assessment of causes of failure of expansion joints in a roadway above the station. Expert witness.

Besses o' th' Barn Railway Bridge, Manchester

Structural survey, assessment and testing of 160m long post-tensioned segmental concrete railway bridge over the M62 to determine reasons for extensive cracking and to estimate current load carrying capacity to BS 5400. Testing of bridge components for durability and special inspection of internal and external post-tensioned cables to determine condition and residual stress, with use of impulse radar to identify hidden defects including voids in tendon ducts.

Bridge Checking

Docklands Light Rail 3-Car Capacity Enhancement Project. Project Director for the checking of 28 separate structures required to carry increased loading caused by longer trains.

Independent Category II Checks of precast prestressed concrete T and M beam bridges.

Category III check for the Foyle Bridge in Derry, N. Ireland comprising both steel box girder and post-tensioned concrete viaducts.

Expert Witness

123 Buckingham Palace Road, London.

Acting on behalf of the facilities manager for a building located over a London Railway Station where bridge expansion joints on the service access road were leaking into pedestrian areas of the station below. Excess wear caused by public vehicles and coaches was disputed by the local authority leading to successful claims resolution in the Technology and Construction Court.

Tennison Road Bridge, Croydon.

Dispute resolution between two parties following discovery of unforeseen structural behaviour during bridge demolition resulting in additional works.

Accident Review of Parapet Failure.

Advice given in the case of the specification for a steel vehicle containment parapet on a bridge which had failed to contain an errant transit van. Factors included poor workmanship and installation.

Settled out of court.

Research

Stainless Steel Reinforcement Study, for the Highways Agency.

Investigation into the use of stainless steel reinforcement in bridges subject to various exposure conditions resulting in the publication of Technical Memorandum BA 84/02 – The Use of Stainless Steel.

Integral Bridges Study Tour. Part of a 6 strong delegation investigating the design and construction of Integral Bridges by US and Canadian transportation and research departments. Joint author of the study report available from the Concrete Bridge Development Group.

The Appearance of Bridges and Other Highway Structures.

Author of the chapter on Bridges for Motorway Widening for the book published by the Highways Agency giving aesthetic advice on the issues affecting bridge appearance.

Site Supervision

M42 Motorway Lickey End & Umberslade Site supervision. 1983-1985

New Runnymede Bridge, Surrey.
Carries the M25 over the River Thames. 1979

Committees

- ICE Bridge Engineering Advisory Panel for the ICE Journal 2011 – 2018.
- British Standards Institution B/525/10 Committee – Oversees the publication of all Bridges Standards. Chairman 2005 – 2013.

- Concrete Bridge Development Group – Council, Membership, Activities and Technical Committees 1996 – 2013.
- Concrete Bridge Development Group – Chairman 2002 – 2004.

- Concrete Bridge Development Group – Task Groups on the Design of Integral Bridges and Bridges for Motorway Widening 1995 – 1998.
- Midlands Branch Committee of the Institution of Structural Engineers 1995 – 1997.

Publications & Lectures

"Design Considerations for the Rapid Installation of Bridges".

Seminar for Civils 2005 at Olympia, London. November 2005.

"Concrete Footbridges".

Global Construction: Ultimate Concrete Opportunities Conference at Dundee University. 6 July 2005. RS Cooke.

"The Concept and Construction of Integral Bridges".

Seminar in Kuala Lumpur, Malaysia organised by JKR and the Road Engineering Association of Malaysia. 22 July 2003. RS Cooke.

"Design for Durability of Structures".

PTRC Training Lecture for "Bridge Inspection and Management Techniques" Course. TRL, Crowthorne, 11 May 1999 & Edinburgh University 3 November 1999. RS Cooke.

"Integral Bridges in Ireland".

Seminar of the Institution of Structural Engineers, Dublin. 8 March 1999. J Caffrey and RS Cooke.

"Integral Bridges - Report of a Study Tour to North America. Technical Guide No.1".

Publication and Seminar of the Concrete Bridge Development Group, November 1997 (BA Nicholson, JM Barr, RS Cooke, RP Hickman, CJFP Jones and HPJ Taylor).

"The Appearance of Bridges and Other Highway Structures".

The Highways Agency 1996. Author of chapter on Bridges over Widened Motorways. (Co-author).

"Integral Bridges - Superstructures and Continuity".

Annual Seminar of the Concrete Bridge Development Group, Dunchurch. March 1996. RS Cooke.

"The Design of Integral Bridges".

Seminar of the Concrete Bridge Development Group, London. October 1995. RS Cooke.

"Besses O' Th' Barn Bridge. Inspection and Testing of Segmental Post-Tensioned Concrete Bridge".

Proceedings of the Institution of Civil Engineers Structures and Buildings, February 1995. MJ Blacker and RS Cooke.

Lecture on the "Inspection of Post-Tensioned Concrete Bridges".

IHT/IStructE joint meeting, Gateshead October 1994.

"Widening Bridges for the M1 and M6 Motorways".

Bridge Modification Conference - Wider and Longer. Institution of Civil Engineers 23 March 1994. AM Paul and RS Cooke.

"Besses O' Th' Barn Bridge. The Assessment and Testing of a Segmented Post-tensioned Concrete Bridge".

Construction Marketing Symposium on Bridges - Extending the Lifespan, May/June 1992. RS Cooke.

Lecture on the "Assessment of Concrete Bridges" to the Edinburgh and East of Scotland Associations of the Institution of Civil Engineers, November 1991.

"The Design of Bridges for the M40 Motorway in Areas Subject to Mining Subsidence" in the proceedings of 2nd International Conference on Construction in Areas of Abandoned Mineworkings Edinburgh 28-30 June 1988. RS Cooke.

A COMMUNITY APPROACH TO ENABLING SUSTAINABLE FOOTBRIDGES

By Matthew Bowser, P.Eng., and Débora Bowser, M.Sc.

Bridging the Gap Africa

ABSTRACT

This paper introduces a community footbridge program in Kenya that is facilitated by Bridging the Gap Africa, a non-profit organization that partners with rural isolated communities to enable safe access over dangerous rivers.

Background information on the organization is provided followed by a general update on Bridging the Gap Africa's technical program.

The development of a standardized short span suspension bridge is presented along with a brief overview of the recently completed 55m span Oltulelei Suspension Bridge near the Masai Mara region of Kenya.

Implementation of the Vetiver System as a bio-engineered method for river bank protection is also presented in the form of a case study for a recent trial site in Western Kenya.

The paper concludes with a lesson learned with respect to how understanding socio-economic factors are important to promote successful bridge projects in rural communities.

BACKGROUND

Over the past 20 years Bridging the Gap Africa has enabled 63 footbridges throughout East Africa.

We are a non-profit organization that believes rural marginalized communities should not suffer due to the separation caused by dangerous rivers.

The footbridges that we enable save lives by preventing accidental drownings and animal attacks while bringing social change by increasing access to education, health care, and economic opportunity.

Financial support for our bridge program comes primarily through corporate and private donors in the United States and Canada.

Our bridge program is founded on the principle of partnering with communities to enable their bridge.

This is made possible through a strong in-country team of skilled Kenyan workers that form the core of our operations.

In Kenya, we have a Graduate Engineer (equivalent to the EIT designation in North America) that assists with design and project management and a Team of skilled tradesmen that consist of superintendents, foremen, ironworkers, carpenters, concrete finishers, and masons.

This core Team prepares for bridge builds at our operational base in western Kenya by fabricating structural steel, bending rebar, and preparing concrete formwork.

The core Team then travels to each bridge site where we partner with communities by hiring a local group of workers who become the bridge crew.

Our hope is that with this model we are taking steps towards making our role as a non-profit redundant. With the skills required to design, build, and manage these footbridge existing entirely within Kenya, the only missing component for future projects would be funding.

With time, it is our hope that funding for this infrastructure would come entirely from within the country.

The technical program at Bridging the Gap Africa is supported by a group of several volunteer Professional Engineers from consulting companies such as WSP, HNTB, JACOBS, and others.

Design Development and Methodology

In 2013 WSP Canada (through their legacy MMM Group) sponsored Bridging the Gap Africa by providing engineering services for the development of a short span suspension bridge that would go on to form the bases of a standardized footbridge design used by Bridging the Gap Africa throughout Kenya.

Prior to 2013, Bridging the Gap Africa had primarily built suspended (hanging) footbridges.

Standard suspension bridge designs from other organizations were reviewed jointly by WSP and Bridging the Gap Africa in 2013 and it was found that the structural detailing that was being used successfully in other countries would be difficult to fabricate in rural Kenya.

Since Bridging the Gap Africa is founded on the principle that we partner with communities to build their bridges, it was essential that we develop a design that allowed for fabrication in rural Kenya by local ironworkers.

With this goal in mind, the bridge group at WSP started on an iterative process in which structural details were proposed, reviewed by Bridging the Gap Africa for constructability, revised, reviewed again, etc.

The primary structural system for the short span suspension bridge developed with WSP matches what is used by other organizations in that the towers have a pinned connection at their base with the suspension cables fixed in saddles located at the top of the towers.

During the development of Bridging the Gap Africa’s standardized suspension bridge the following design criteria was utilized:

- Full compliance with all the Ultimate Limit State (ULS) requirements of Canadian Highway Bridge Design Code (CHBDC) CAN/CSA S6-06;
- Welds would be utilized for connection design but primary load paths within the structure do not rely on weld strength; and
- All structural steel detailing utilized straight, right angle (90°) cuts such that hacksaws or grinders with cut off disks could be utilized for all cuts.

The initial suspension bridge design developed in partnership with WSP utilizes details that can be produced easily by local iron workers in rural fabrication shops.

Rectangular Hollow Sections (RHS) are used for the towers along with steel angle cross bracing. Gusset and connection plates are limited to a maximum plate width of 125mm corresponding to the largest commonly available size of flat bar.

A built-up section using flat bar, angle sections, and steel pipe is used for the hinge and saddle connections at the base and top of the towers respectively.

Using a built-up section enables the structural detailing to stay within the design criteria by utilizing only straight cuts.

The initial suspension bridge designed in partnership with WSP was constructed in 2015. Deliverables provided by WSP for this initial suspension bridge included a stamped structural design report and a full set of drawings.

Since 2015, Bridging the Gap Africa has enabled six (6) footbridges that have been designed based on the standardized short span suspension bridge that was developed in partnership with WSP.

The subsequent footbridges were designed specifically for each site by Professional Engineers that volunteer their services as members of Bridging the Gap Africa’s Technical Advisory Committee.

The most recent suspension bridge that has been designed and constructed by Bridging the Gap Africa is the 55m span Oltulelei Suspension Bridge.

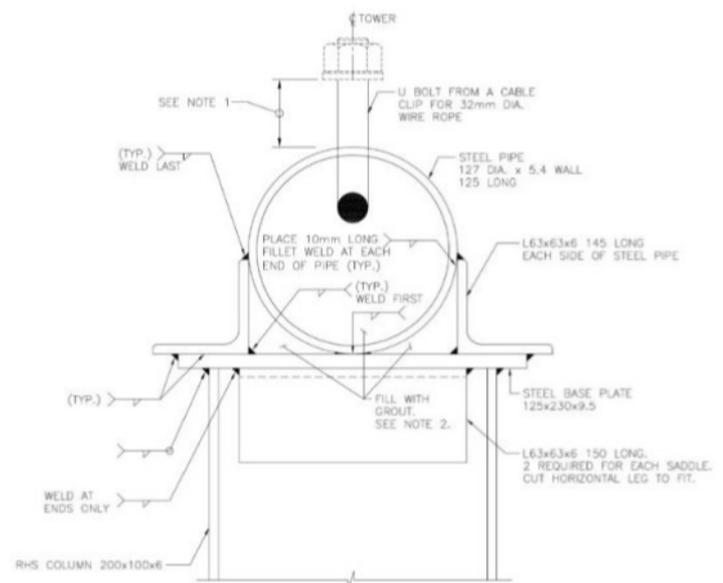


Figure 1: Detail for the saddle connection (hinge connection at base of towers is similar)



Figures 2 + 3: Opening ceremony for the Oltulelei Suspension Bridge (left) with community members crossing the bridge (right). Masai Mara, Kenya (photos by Micah Conway)

Oltulelei Suspension Bridge

The 55m Span Oltulelei Suspension Bridge crosses the Sand River in the Masai Mara region of Kenya (GPS 1° 42'06" South, 35° 25'46" East). The Sand River is a seasonal river and during the rainy seasons this bridge provides safe access to markets and health care.

The bridge has steel towers that are 7.2m in length which are supported by reinforced concrete abutments. Two (2) 32mm diameter wire rope cables (one on either side of the bridge deck) support the span.

The cables tie into reinforced concrete beam anchors. The timber plank bridge deck is supported by transverse RHS cross beams which tie into longitudinal RHS stiffening rails and diagonal steel angle wind bracing.

The steel framing system for the deck is supported by steel round bar suspenders. Some of the key components of this bridge are described in the following sections.

Towers

The RHS towers for the Oltulelei bridge are 7.2m in height and required a tower splice as the longest commercially available length of RHS in Kenya is 6.0m. A bolted connection was used to facilitate the tower splice.

A bolted connection was chosen over a welded shop splice to assist with transport. Getting lorries to this bridge site was particularly challenging and keeping the maximum length of sections for transport to 6.0m eliminated the need for a flat deck or long box lorry.

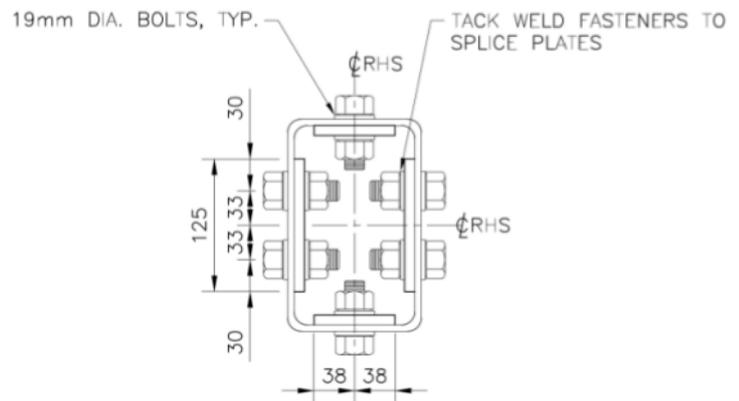


Figure 4: Steel detailing for tower splice with tack weld of nuts to allow for a blind connection

To reduce material and fabrication costs and to improve aesthetics, a single splice plate on each inside face of the RHS was used for the connection.

Since the inside nut was not accessible, a spot weld was utilized to eliminate the need for a spud wrench on the inside of the RHS. This enabled a blind connection.

Patrick Macharia is a local (rural) steel fabricator in Western Kenya that Bridging the Gap Africa hires as a sub-contractor for steel fabrication.

To date, Patrick has fabricated six (6) suspension bridges as well as several suspended (hanging) bridges for communities throughout Kenya.

Patrick's fabrication shop which is a common representation of facilities found in rural Kenya. Please understand that Kenya has several advanced steel fabrication shops in Nairobi and other large cities.



Figures 5 + 6: Fabrication of 7.2m tall steel towers by Patrick Macharia (photos used with permission)

What we are wanting to illustrate is that the design and detailing for Bridging the Gap Africa footbridges are custom tailored to enable high quality fabrication within rural facilities.

Tower Foundations

The steel towers are supported by reinforced concrete abutments that consist of a spread footing, concrete pilasters, ballast wall, and bearing pedestals. The ballast wall enables an earth filled concrete walled ramp.

Lateral earth pressures on the ballast wall result in an overturning moment that generates a non-uniform demand on the foundation which is accounted for in the design of the spread footing.

The concrete bearing pedestals house steel pipe inserts that allow for a steel pin hinged connection at the base of the towers.

Suspension Cables

Bridging the Gap Africa utilizes steel wire rope as the suspension cables for these community footbridges. The Oltulelei Suspension Bridge has a single 32mm diameter cable on either side of the bridge deck.

The cables are installed manually (by hand) without the use of a crane or any other large equipment. The cables are initially carried across the river by the bridge crew with the aid of a lead line if needed depending on water depth at the time of construction.



Figure 7: Setting the main cables for the 55m span

Cables are then pulled up and over the saddles at the top of the towers. The cables are set to a specified sag as opposed to a specified tension. After the cables are set within the saddles at the top of the towers the dead end of the cables is fastened to the anchor.

At Oltulelei, a Toyota Landcruiser was used to roughly set sag in the cables by using a rigging system to temporarily tie the main cables to the front tow bar on the truck.

The truck was then reversed within the back-span to tighten the cables. The cables were overtightened such that cable height at mid-span was higher than the specified sag.

A process was then employed where the wire rope clips are set snug but not tight and a tirfor machine is used to provide a secure and controlled release of the cables down to their specified sag elevation after which the wire rope grips are fully torqued.

Through our experience we have found that it is easier to lower the cables to their specified sag by loosening as opposed to raising the cable to its specified sag by tightening. Loosening the cable can be performed with a higher level of precision.

Bridge Anchors

During the initial site assessment for the Oltulelei Suspension Bridge a test pit was dug within relatively close proximity of the anchor locations on both sides of the Sand River under the supervision of a Professional Engineer.

The engineer provided a visual classification of the underlying soils which was used to determine appropriate coefficients of passive earth pressure used for the anchor design.

The design resulted in having the cables anchored to a 5.5m long reinforced concrete beam that was set 2.3m below grade.

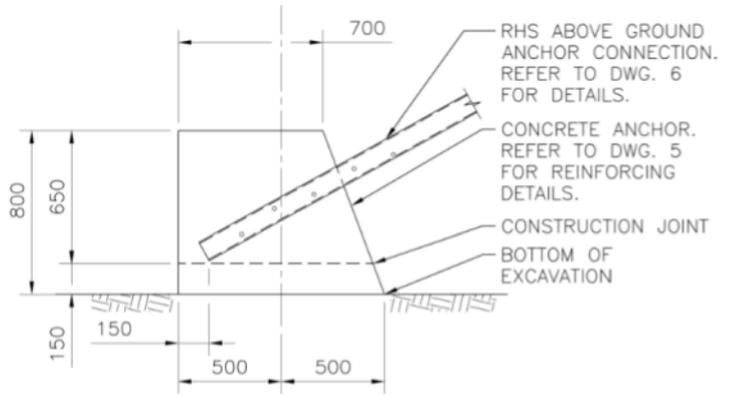


Figure 8: Section showing the concrete beam anchor (reinforcing steel not shown for clarity)

The beam anchor relies on passive earth pressures on the front face of the anchor to resist the pull of the main cables. Uplift forces on the anchor are resisted by gravity loads provided by the concrete beam and the earth backfill that is on top of the anchor.

A connection between the suspension cables and the concrete beam anchor is facilitated by a steel RHS section that is tied into the reinforcing cage of the beam anchor using L dowels.

Connection of the main suspension cables to the RHS is done above ground to allow for ease of construction and to facilitate future inspection of the cables.

Deck System

The deck system for the Oltulelei Suspension Bridge consists of longitudinally placed timber planks that are fastened to transverse RHS cross beams.

The deck cross beams connect to longitudinal RHS stiffening rails on each side of the bridge deck that extend the full length of the bridge and terminate within the reinforced concrete ballast walls.

Diagonal steel angle wind bracing provides lateral stiffness for the deck to reduce the magnitude of side sway.



Figure 9: BTGA's bridge builders nailing deck boards with view of the steel detailing

A common point was used to connect the stiffening rails and wind bracing to the transverse cross beams. This resulted in having a truss (in plan view) along the entire length of the bridge to help reduce lateral movement of the span.

The longitudinal stiffening rails also paired with the timber deck boards to enable a “couple moment” that reduced excessive deflections within the deck system.

Since cable supported bridges need to deflect to carry load, the goal was not to eliminate deflection within the span but rather reduce movement of the bridge deck to provide for more comfortable service.

The entire deck system is support by steel round bar suspenders which hang from the main suspension cables.

Lesson Learned

One of the lessons learned on the Oltulelei Suspension Bridge and other similar projects is that the RHS tower sections commonly come with a minor sweep (or as we call it a “banana shape” bend).

Our steel fabricator unsuccessfully tried to correct these bends by attempting to straighten the RHS through mechanical means. Ultimately the decision was made for Oltulelei by the design engineer to leave the sweep in the RHS.

The towers were checked for the added P-Delta effect and it was determined that there was enough reserve capacity in the column design to accommodate the sweep.

Fabrication was modified by orientating the sweep in each RHS towards each other at the centre of the bridge and shortening the mid-height lateral cross brace to suit.

This enabled the spacing between the RHS at the top and bottom of the towers to be maintained at 2.0m on centre.

Vetiver System for Riverbank Stabilization

Several footbridges enabled by Bridging the Gap Africa have been constructed over rivers that are extremely vulnerable to erosion.

Traditionally, our Team has taken a multi-disciplinary approach to reducing risks associated with riverbank erosion by providing generous offsets for the abutments from the top of the river banks, locating bridges away from river bends and meander belts, and choosing bridge locations that have good rock outcroppings (when possible).

Despite these efforts, riverbank erosion continues to be a significant threat to footbridges throughout East Africa.

To reduce the risks associated with riverbank erosion our technical Team reviewed several different traditional engineered solutions that may slow down erosion at various bridge sites; however, accessing and transporting materials for these traditional solutions (including gabions) is difficult and expensive.

In search of an alternative solution, we came across a bio-engineered system involving deep-rooted vegetation with fast establishment that could aid in the reinforcement and stabilization of soil along riverbanks.

This bio-engineered alternative, called the Vetiver System (VS), showed high potential to offer river bank stabilization for these bridge sites at minimal cost.

Vetiver Grass (*Chrysopogon zizanioides*), a non-invasive and sterile species, is known to offer land stabilization at riverbanks. Several studies have shown that Vetiver Grass has a deep-root system with a tensile strength of 75 MPa (Hengchaovanich and Nilaweera, 1996), increasing soil shear strength by 36% (Mickovski and Van Beek, 2009).

Mature Vetiver plants can survive harsh conditions (Greenfield, 2002; Troung et al., 2008), including being submerged by water for a period of two months (Xu, 2002).



Figure 10: Local community members placing sand bags as part of a Vetiver System

Vetiver's special morphological and physiological attributes have proven to be very effective in stabilizing road embankments and reducing riverbank erosion (Dalton, 1996; Greenfield, 2002; Islam et al., 2013; Jasper-Focks and Algera, 2006; NRC, 1993).

Based on this information we decided to implement the Vetiver System to reduce the risks associated with riverbank erosion at a bridge site in Western Kenya (GPS 0°45'09" North, 34°59'08" East).

We were successful in sourcing vetiver grass from a nursery near the bridge site and on December 10th, 2018, we began planting at the bridge site. 215 "sand" bags (containing mixture of sand, soil and manure) were placed in critical areas where the loss of soil was severe.

In total our Team planted 6,250 vetiver slips between the two sides of the river. Slips were planted in sand bags and directly in soil. Planting was completed in three (3) days, with the participation of 12 local community members (6 members from each side of the river).

Since the completion of planting we have implemented regular monitoring at this site to keep track of the vetiver grass growth and development.

At the time of writing this paper we wait in anticipation as the rainy season approaches to find out how well the vetiver grass will perform.

If this proves to be a successful method for protecting riverbanks we will be looking to implement the Vetiver System at future bridge sites throughout East Africa.

Socioeconomic Considerations

At Bridging the Gap Africa, we are constantly looking to improve how we support and partner with local communities and we have learned that successful projects require a good understanding of local socioeconomics at each bridge site.

This section shares a lesson learned on this topic. Through our partnership with WSP, we had a Senior Fluvial Geomorphologist take a detailed look at one of our proposed sites and provide recommendations with respect to bridge location and offsets for abutments from top of bank.



Figures 11 + 12: Riverbank before (December 10, 2018) and after (May 21, 2019) implementing the Vetiver System to provide riverbank erosion protection.

This site was particularly vulnerable to erosion. Aerial imagery was used dating back over a 50+ year period to look at movement of the river.

Based on this information, a proposed location for the new bridge was recommended; however, it was not until we were in construction that we came to a surprising observation.

We realized that during the early hours of the morning, individuals geared with a shovel, would enter the river and begin sand harvesting from the river banks.

We later came to learn that sand harvesting was a common business within this community.

Through this experience we learned that having a comprehensive understanding of local socioeconomic factors is critically important in the development of sustainable designs.

CONCLUSIONS

Bridging the Gap Africa is an organization committed to partnering with communities to enable bridges that provide safe access over dangerous rivers.

We realize that to have lasting impacts it is essential to develop in-country talent that can design, build, and manage bridge projects.

While our technical program is supported by international consulting firms and Professional Engineers from abroad, we actively invest in building the expertise needed in Kenya with the anticipation of a realizing a fully independent organization that one day will operate without external support.

The designs that have been developed through Bridging the Gap Africa are custom tailored for use in Kenya.

This results in a sustainable approach that utilizes local materials and production methods that can be easily accommodated in remote communities.

If you would like to join us by investing in the development of our Kenyan Team and enable them to build more life changing footbridges please reach out to Matthew Bowser:

Matthew@Bridgingthegapafrika.org

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HOW TO CARRY OUT MAINTENANCE WORK WITH MINIMAL TRAFFIC DISRUPTION

Robert Percy

Director, COWI, United Kingdom

How do you keep infrastructure open to traffic while performing crucial maintenance work? The question is vital to ensure mobility in dense cities and avoid large road closure costs – both environmentally and economically.

Owners and operators of urban infrastructure find themselves in a difficult situation. Urban populations are expanding rapidly, meaning much of our infrastructure is handling traffic far exceeding that envisaged at the time of design. This leads to increased rates of degradation and fatigue.

Furthermore, due to the impact of exhaust fumes on air quality, congestion has become a health and environmental issue, as well as an economic one. This makes it less acceptable to close highways or implement congestion-creating speed restrictions and lane closures – even for vital maintenance work.

In other words; with urban road networks at maximum capacity, owners and operators need to find ways of keeping traffic flowing while they carry out maintenance work.

CLOSING THE UK'S MOST IMPORTANT BRIDGE WAS NOT AN OPTION

Let's take a closer look at one such example.

Recently, Connect Plus, the operator of the Queen Elizabeth II (QE2) Bridge in London, UK, needed to carry out vital maintenance work on the bridge, which carries 80,000 vehicles a day.

Opened in 1991, the cable-stayed bridge carries the clockwise carriageway of London's orbital highway, the M25, over the River Thames.

Due to age and fatigue, the bridge's six movement joints needed to be replaced, requiring the removal of deck sections up to 4.5m long.

However, closing the UK's most important bridge to carry out the work was not an option.

CHALLENGING THE INDUSTRY STANDARDS

The standard industry solution at the time – deploying steel plates over the joints – had a number of drawbacks: they restricted vehicles to 30mph, could not span double joints, did not cater for long span bridge movement and can block access from one side.

This option was clearly not going to meet the requirements for the QE2 Bridge.

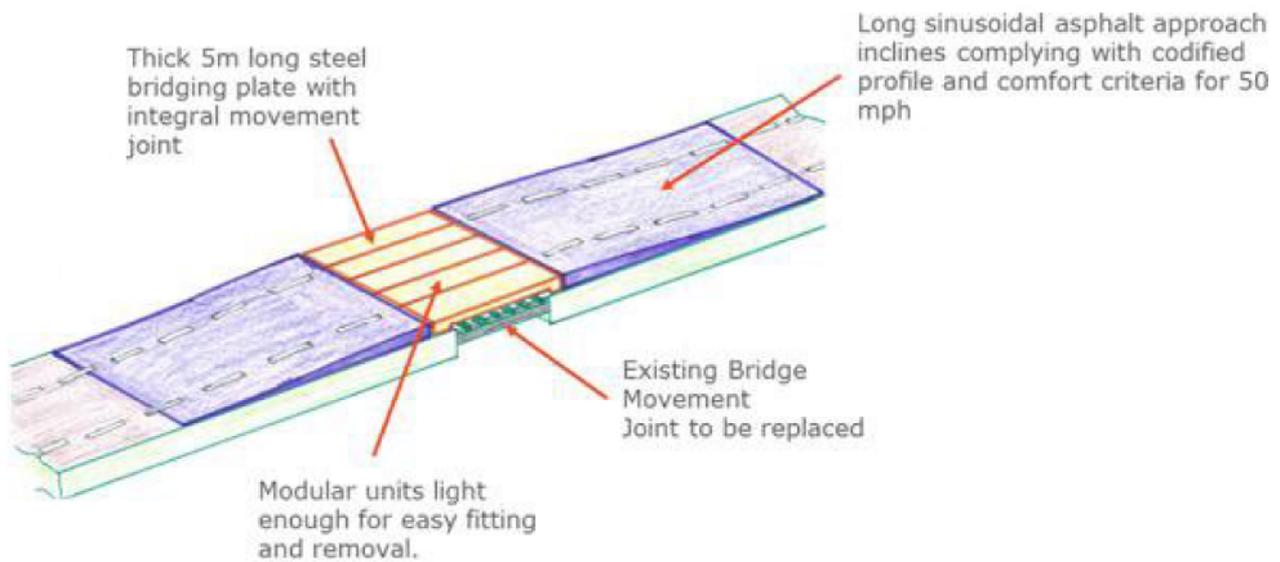
A new solution was needed that did not require severe speed restrictions, could accommodate up to +/-350mm longitudinal movement and allowed work to be undertaken while traffic was flowing.

NEW SOLUTION KEPT TRAFFIC DISRUPTION TO A MINIMUM

In close collaboration with our client, Connect Plus and contractor Jackson, we developed an alternative solution: a temporary over-bridge system that allowed traffic to flow while the existing movement joint was removed from the underside of the bridge.



Queen Elizabeth II (QE2) Bridge



Temporary over-bridge system

The temporary system (pictured above) comprised two sinusoidal asphalt approach inclines and a 5m long central steel bridging plate with integral movement joint.

Light enough for easy fitting and removal, the modular units were installed over the existing joint during a single night closure.

Once the old joint was removed, the new permanent joint was installed during a single night closure, meaning disruption to traffic was kept to an absolute minimum.

500T OF CARBON AND MILLIONS OF POUNDS SAVED

By maintaining traffic flow and speed, the bespoke over-bridge system saved over 500t of carbon and millions of pounds in road closure costs. And, crucially, the repair work was invisible to motorists.

The system enables the replacement of movement joints while maintaining high-speed traffic flow (50 mph), and it is now used across the M25 and beyond.

In recognition of its game-changing impact, the project won Temporary Works Initiative of the Year at the 2015 British Construction Industry Awards.



Queen Elizabeth II (QE2) Bridge

MEET THE EXPERT – ROBERT PERCY

My primary field of expertise is the strengthening, refurbishment and upgrade of bridges, with particular focus on long span, historic and critical infrastructure structures.

This field takes me from projects on my doorstep, to those on the other side of the world.

There are never two problems the same, and rarely an easy solution. It is a never-ending challenge that weaves through different cultures and different places.

AWARD CEREMONY OF THE "BERD-FEUP WIBE" PRIZE

Brigitte Rouquet, BERD

PRIZE

Launched in 2015, the World Innovation in Bridge Engineering Prize aims to share the success of the R&D model that construction equipment company BERD and the Faculty of Engineering of the University of Porto (FEUP) have been applying in recent years at an international level and to keep both institutions in touch with the forefront of international bridge engineering while, at the same time, contributing to its evolution.

The leaders of BERD and FEUP point out that 21st century civil engineering has changed drastically, and international markets have much larger dimensions when compared to the national market. They also add that global infrastructure needs are enormous, as highlighted in reports from international bodies such as the United Nations.

BERD and FEUP are associated with the launch of the "BERD-FEUP WIBE" World Innovation in Bridge Engineering Prize, with the belief that this is an opportunity to internationally promote existing national and international bridge engineering capabilities - capabilities that exist both in the field of R&D as well as the fields of industry and services. BERD and FEUP consider it important to recognise these capabilities and have taken an active role in their promotion.

According to João Falcão e Cunha, director of FEUP, "*This is the first award, launched nationally and internationally, focused on innovation in bridge engineering*" and should therefore be considered "the Nobel Prize for Bridges". This is an excellent opportunity "*to promote existing high capabilities in the field of bridge engineering at an international level*".

In turn, Pedro Pacheco, CEO of BERD, emphasises that "*The World Innovation in Bridge Engineering Prize established by the BERD and FEUP - WIBE Prize - is already a reality and a reference of international prestige. Focused on useful innovation for society, it has the recognition and active support of the field's most important international associations. With thousands of followers in more than 150 countries, it is a challenge of creativity that is already in the imagination of bridges engineers from all over the globe.*"

REASONS FOR CHOOSING AN AWARD IN THIS ENGINEERING SECTOR

"Portuguese bridge engineering is well placed to occupy a leading position on the international map of bridge engineering," says Pedro Pacheco, President of BERD, going on to say that "*the organising of an award with this kind of scope constitutes a huge responsibility and a great challenge for Portuguese bridge engineering*".

"The BERD-FEUP WIBE Prize has challenged engineers to believe that innovation is the seed of development", said Pedro Pacheco, for whom boundaries are drawn for the bridge construction sector on a daily basis.

Within that area, the global bridge engineering and scientific research community is invited to participate in this innovative award, which aims to share the success of the R&D model that BERD and FEUP have been applying in recent years at an international level.

JURY

Composed of renowned engineers of the world's most important entities in the field of Bridge Engineering (IABSE – International Association for Bridge and Structural Engineering; FIB – Fédération Internationale du Béton; IABMAS – International Association for Bridge Maintenance and Safety; AISC – American Institute of Steel Construction; ECCE – European Council of Civil Engineers; ASCE– American Society of Civil Engineers; FEUP – Faculty of Engineering of the University of Porto and BERD – Bridge Engineering Research & Design) giving particular focus to the following aspects:

- Innovation: Innovative features of the article;
- Innovation impact in the field of bridge engineering;
- Innovation impact on society;
- Consistency: Scientific consistency as well as technical application.

PARTICIPATION ASSESSMENT IN THE FIRST EDITION

The first edition of the World Innovation in Bridge Engineering Prize had a very active participation, which exceeded all expectations in terms of quality and quantity. Applications were evaluated involving more than 200 authors from around 50 countries.

In 2015, the award was launched, and stakeholders were invited to submit a 10-page (maximum) work in the field of bridge engineering, comprising at least four of the following requirements:

- A concept, process or system with clear characteristics of innovation in bridge engineering;
- A clear presentation of the potential impact of innovation in bridge engineering;
- A clear presentation of the potential impact of Innovation on society;
- A clear presentation of the scientific validation or, alternatively, a clear presentation of the potential for technical applicability.

WINNER OF THE WORLD INNOVATION IN BRIDGE ENGINEERING PRIZE

The winner of the first World Innovation in Bridge Engineering Prize is a group of authors from the University of Queensland, Australia who will be awarded the prize money of US\$ 50,000.

“Novel bridge system for durable, low-cost and rapid construction”

With the following authors:

L. de Waal, S. Jiang, S.R. Hislop-Lynch, D. Fernando & S. Ahn

The School of Civil Engineering, The University of Queensland, St Lucia, Queensland, Australia

J.G. Teng

The Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong, China

P. Rodma

The Rocket C Pty Ltd, Brisbane, Queensland, Australia

P. Burnton

Arup Pty Ltd, Brisbane, Queensland, Australia

Prominence was given to the authors of the work for having demonstrated the greatest potential for innovation and contributing to the development of global bridge engineering, selected by a qualified Jury composed of 13 members, ten of whom are international experts.

OTHER HIGHLIGHTED WORKS

WIBE Prize Merit Awards

“The TVTδ “Rainbow” bridge: a new technique for long-spanned highly transparent footbridges”

Authors:

Maurizio Froli, Department of Energy, Systems, Territory and Construction Engineering, University of Pisa, Italy

Francesco Laccone, Department of Energy, Systems, Territory and Construction Engineering, University of Pisa, Italy

Agnese Natali, Department of Civil and Industrial Engineering, University of Pisa, Pisa, Italy

“São Silvestre footbridge: an innovative GFRP- SFRSCC hybrid structural system”

Authors:

J.A. Gonilha, J.R. Correia & F. Branco, CERIS, Instituto Superior Técnico – University of Lisbon, Portugal

J. Barros, J. Sena-Cruz, ISE, Minho University, Portugal

Tomé Santos, ALTO Perfis Pultrudidos, Portugal

BRIEF DESCRIPTION OF THE WORKS AWARDED

(please find more information in the pdf below)

Winner of the World Innovation in Bridge Engineering Prize

“Novel bridge system for durable, low-cost and rapid construction”

The Winner of WIBE Prize is the work of a long term R&D project aimed at developing an innovative bridge system which will allow sustainable and rapid construction. Proposed novel bridge system, hybrid double skin tubular arch (DSTA) bridge consists of an outer fibre reinforced polymer (FRP) tube, an inner steel tube, and a layer of concrete sandwiched between them.

The proposed DSTA type of bridges are light-weight, durable, low-cost, low embodied energy and rapid to construct, thus providing a highly attractive alternative to traditional bridge design.

WIBE Prize Merit Awards

“The TVTδ “Rainbow” bridge: a new technique for long-spanned highly transparent footbridges”

The work that will receive the First Merit Award is a new approach of what could be the visual experience of a pedestrian while looking at or while walking on a pedestrian bridge.

The innovation - ‘The TVTδ “Rainbow” bridge’ is centered on how to build an almost transparent footbridge with a relevant free span. A structural glass solution is proposed which simultaneously meets the requirements of adequate safety levels and cost effectiveness. The project is inspired by the idea of an evanescent connection for a weightless experience of crossing and a visual effect of transparency and sunlight reflections.

“São Silvestre footbridge: an innovative GFRP- SFRSCC hybrid structural system”

The work that will receive the second Merit Award shows that to achieve quality and effective improvement there is no need for dimension. In this work we can see a very light composite pedestrian bridge, allowing for very quick installation, with high durability and electro-magnetic transparency; initially designed for railway pedestrian overpasses, as an alternative to classical railway crossings, it can be applicable to any kind of needs in terms of pedestrian pathway.

ABOUT THE MEMBERS OF THE ORGANIZATION

FEUP: An internationally renowned institution

With its origins going back to the eighteenth century, the University of Porto (U.PORTO) is currently one of the most prestigious Institutions of Higher Education in Europe. It has approximately 32 thousand students and 2400 teachers and researchers, as well as 1600 staff members in its 15 schools and 60 scientific research units located on three university campuses in the city of Porto.

The Faculty of Engineering of the University of Porto (FEUP) is the largest of the 14 Faculties that constitute the University of Porto, with close to 8000 students, 63 courses and about 600 professors and researchers in 9 Engineering Departments: Chemistry, Civil, Electronics and Computers, Industrial and Management, IT and Computing, Mechanics, Physics, Metallurgy and Materials and Mining and GeoEnvironment.

FEUP is located in a real Innovation Hub, where the strong presence of engineering, health sciences and entrepreneurship are highly conducive to the innovation process. Also located here is the Science and Technology Park of the University of Porto (UPTec), a fundamental structure to support the transfer of knowledge between the university and the market.

More information at: www.fe.up.pt

BERD: One bridge one solution

BERD - Bridge Engineering Research & Design - provides integrated Bridge Engineering solutions and acts in the sale or rental of large equipment for the construction of bridges. Its vision is to be a world leader in the area of solutions and constructive methods for the construction of bridges and viaducts, currently placed in the TOP 3 of this area of activity.

The service provided by BERD goes beyond the mere supply of machinery, since, in most cases, it develops the solution and coordinates the project and its operation. It presents its clients with an integrated solution that consists of an interaction between project - constructive method - construction.

BERD has also invested in new business areas, such as modular bridges, and the development of new products.

More information at: <https://www.berd.eu/>

Contacts

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Bridge to the Future to help beat Cancer

Lawrence Shackman



View of the Queensferry Crossing

STORY

I was the Project Manager for the Queensferry Crossing Bridge which opened just over a year ago.

Sadly my mother passed away from cancer just a few weeks later. She was so impressed with the bridge and I suppose my efforts in getting it built but I would like to go further

I would like to help find a cure for this terrible disease which has claimed the lives of so many including my father, uncle and mother-in-law.

So, I have written and produced a song and video to celebrate the bridge construction and by watching the video I would then like people to donate to Cancer Research UK – any donation is very welcome!

*See the video on my
LinkedIN or Facebook pages.*



Thank you for taking time to visit my JustGiving page.

ABOUT THE CHARITY

Cancer Research UK



Cancer Research UK is the world's leading charity dedicated to beating cancer through research. We are fighting cancer on all fronts, finding new ways to prevent, diagnose and treat it to save more lives. We are entirely funded by the public. With your help, we can ensure more people beat cancer.

Charity Registration No. in England and Wales 1089464, Scotland SC041666

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9TH INTERNATIONAL CONFERENCE ON ARCH BRIDGES

PORTO
OCTOBER 2 > 4
2019

Under the theme “Arch Bridges – Natural beauty for all time”, the 9th International Conference on Arch Bridges (ARCH 2019), will be held in Porto, Portugal, on October 2 to 4, 2019. The conference will be organized by the Civil Engineering Department of the Faculty of Engineering of the University of Porto.

Since the first ARCH Conference (UK 1995), seven subsequent editions took place (Italy 1998, France 2001, Spain 2004, Portugal 2007, China 2010, Croatia 2013 and Wrocław 2016), all high quality and successful events. Stemming from such heritage, it is our pleasure to invite you to the next 2019 ARCH conference edition.

On behalf of the Organizing Committee we hope you consider accepting this invitation, as we are committing ourselves to provide the best possible for your overall satisfaction during and after the conference.

Sincerely yours,

António Arêde
Chairman of the Organizing Committee

António Adão da Fonseca
Chairman of the Scientific Committee

Rui Calçada
Co-Chairman of the Organizing Committee

Elsa Caetano
Co-Chairman of the Scientific Committee

CONFERENCE MAIN TOPICS

- Heritage arch bridges
- Analytic and numerical studies of arch structures
- Experimental studies of arch structures
- Design and construction of arch bridges
- Rehabilitation, maintenance and condition assessment of arch bridges
- New and future trends in arch bridges

IMPORTANT DATES

Submission of abstracts:
November 2nd, 2018

Acceptance of abstracts:
December 17th, 2018

Submission of full papers:
March 16th, 2019

Acceptance of papers:
May 18th, 2019

Close of early registration:
June 16th, 2019

CONFERENCE VENUE

The conference will be held at the Faculty of Engineering of the University of Porto (FEUP), in one major campus of the University of Porto (UPorto) located at the north limit zone of Porto city (www.fe.up.pt).

CONFERENCE LANGUAGE

English will be the conference official language, including sessions, proceedings and general organization.

The conference website

www.fe.up.pt/arch19

provides more detailed information.

+INFO:

ARCH 2019 Secretariat
Department of Civil Engineering
Faculty of Engineering of
University of Porto

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Queensferry Crossing Scotland



Unique solutions for bridge engineering

RUBRICA BRIDGES

Atlantic Bridge (Panamá) / four form travelers for the construction of a cable-stayed bridge

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BRINGING YOU THE **CEBU-CORDOVA** LINK EXPRESSWAY

Throughout COWI's history, bridges have been one of our primary services. Today, we count a number of the world's highest and longest bridges among our most visible accomplishments. The Cebu-Cordova Expressway will link Cebu, the second largest city in the Philippines, with Cordova municipality on Mactan Island. The 8.5km long toll road will carry four lanes of traffic over the twin-pylon cable-stayed bridge and it is expected that 40,000 vehicles will use the new link every day once complete; cutting travel time and relieving congestion.

Engineers at heart, we continually strive to provide innovative solutions and are eager to work on the most challenging projects around the world.



POWERING YOUR 360° SOLUTIONS

COWI is a leading consulting group that creates value for customers, people and society through our 360° approach. We tackle challenges from many vantage points to create coherent solutions for our customers.

Image: Courtesy of DISSING+WEITLING Architecture

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BUSINESS OPPORTUNITIES IN THE **CZECH REPUBLIC**



The Czech Republic ranks among countries with a strong economy and good potential. According to recent data, industrial production in the Czech Republic has increased by 5.7% year-on-year, and the value of new orders has increased by 6.6% year-on-year. The employment rate has increased by 2% and the unemployment rate is currently around 2.5%

The economic situation of the Czech Republic is very good and gives opportunity to invest in both state and public sectors. State-run organizations are creditworthy and cooperation with them is sought-after.

In the area of public investment, there has been an obvious and long-term effort to open up the market as much as possible and to allow participation of entities with a registered office or place of business outside the Czech Republic. The basis of this trend is given both at the level of the European Union and at the level of national legislation where it is stipulated mainly by Act No. 134/2016 Sb., on Public Procurement.

Due to the simplification of participation in the tender procedure (introduction of a uniform European Certificate, the contracting authority's obligation to accept documents issued under foreign law), there is no restriction on participation in tenders in the Czech Republic provided the participant fulfils the conditions of the tender.

The market is open to companies from the whole world.

The participant shall be well acquainted with the legislation to be able to submit a perfect offer in compliance with any procedure given by the contracting authority – especially in the case of above-the-threshold public tenders which might be of interest due to their financial volume (supplies and services with an estimated value of more than 443,000 EUR or equivalent; construction works with an estimated value of more than 5.548,000 EUR or equivalent).

Due to the fact that the procedure in above-the-threshold public tenders is relatively rigid, and even the minor non-compliance with the conditions by the participant may lead to their disqualification, it is necessary to be familiar with this area or to contact a reliable partner. To conclude, the Czech market offers many possibilities and is open to foreign investors. Czech legislation does not impose any significant restrictions on participation in public tenders, however, it is worthwhile to cooperate with a company which is familiar with the local market, legislation and local customs, and is able to find suitable opportunities.

In the case you are interested in the public tender market in the Czech Republic and intend to apply for public contracts, if you search for answers to your questions or for regular monitoring of relevant opportunities – our company KGS legal s.r.o. as a leading law firm with a focus on public procurement law is always at disposal for you.

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Everyone can be a bridge to a better world.

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BtGA is a 501(c)3 in the US that also has Charitable status in Canada. For more information, please visit the Bridging the Gap Africa website at bridgingthegapafrika.org.



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Our programs provide access to healthcare, education, and markets by teaching communities how to build footbridges over impassable rivers, in partnership with organizations and professionals. We prove the value of our work through a commitment to the community and its bridge that lasts long after the opening celebration.

Contact:

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e-mosty

02 / 2019 JUNE

RICHARD COOKE ON BRIDGES

Oltulelei Bridge



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