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Humber Bridge

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Photo Front Cover: Humber Suspension Bridge. Photo Credit: Cleveland Bridge

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Dear Readers

In the first article of this issue, ***Mark Bulmer*** *and* ***Beverley Urbans*** *bring information on* ***UK Suspension Bridge Cable Inspection and Maintenance*** *with focus on UK´s four longest span suspension bridges: Humber Bridge, Forth Road Bridge, Severn Bridge and Tamar Bridge. In the article they describe the main cables, inspection, process of dehumidification and its operation.*

In the next article, ***Edinson Guanchez*** *provides a brief overview of some aspects that must be considered in a* ***bridge project from a geotechnical standpoint****.*

The third article was prepared by ***Vanja Samec*** *and* ***Gregor Strekelj.*** *They discuss utilization of* ***BIM in Bridge Construction*** *and explain how ALLPLAN works for bridge engineers and what solutions it offers.*

The last article of this issue was prepared by ***Drew Deeter*** *and* ***Bridging the Gap Africa****. Lately Western Kenya has been hit by heavy rains that caused flooding and mudslides with more than one million people affected. Many of the pedestrian bridges which Bridging the Gap Africa has build in this region have been destroyed. You can learn more about BtGA and how to help the people impacted by the flooding in Kenya on bridgingthegapafrica.org.*

At the beginning of 2020 ***e-mosty celebrates five years' anniversary****. Back cover of this issue is dedicated to this anniversary. I would like to thank all the people and companies who have been helping us prepare e-mosty magazine. I think that together we have created valuable content for our readers. We are already looking forward to our cooperation on future editions.*

I am happy to announce that e-mosty magazine has ***two new partners****: ALLPLAN and Arenas & Asociados. We would also like to thank all our partners for their continuous support.*

If you are interested in cooperating with us as our partner, please contact us. General information on partnership with our magazines can be found on page 37 or at e-mosty or e-maritime.

We are preparing a series of ***special editions of e-mosty*** *(the next ones being March and June 2020) and are also working on the content of both e-mosty and e-maritime 2020 / 2021 - you can find more detailed information in our Editorial Plan on page 36.*

I am sorry to say that recently I have realized that MailChimp which I use for subscribers´ administration stopped working. We are trying to resolve the problem, however, if you have subscribed lately and have not received confirmation and / or notification of the recent issue, please contact me directly or subscribe again and will put it into the database manually – I need just your name and email address.

Let me also draw your attention to our other magazine e-maritime whose November Issue provided information on the ***Port of Gävle in Sweden and its extension****, about the project, its design, construction and capping beam formwork with many technical details and drawings. It was prepared in cooperation with the Port of Gävle, Rover Grupo, WSP and Rúbrica to whom I thank for cooperation.*

I would like to thank all the people and companies who have helped me prepare this issue, to all the authors and our partners, to ***Ken Wheeler*** *and* ***Barry Colford*** *(AECOM) for reviewing this issue and for their assistance, and to* ***Guillermo Muñoz-Cobo Cique*** *(Arup) for final checking of the magazine.*

Wish you all the best in New Year 2020.

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 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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e-maritime

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

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

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RUBRICA **MARITIME**

ISSN 2571-3914

UK SUSPENSION BRIDGE CABLE INSPECTION AND MAINTENANCE

Mark Bulmer, Technical Director, AECOM
Beverley Urbans, Associate Director, AECOM

Humber Bridge (top left), Forth Road Bridge (top right), Severn Bridge (bottom left) and Tamar Bridge (bottom right)

INTRODUCTION

Of the UK's four longest span suspension bridges, three have parallel wire main cables and one has parallel strands.

When opened in 1961, Tamar Bridge was the longest span suspension bridge in the UK, with a span of 335m.

Its main cables consist of a series of locked coil ropes, to which are attached locked coil rope suspenders. These in turn support a truss stiffening girder that was originally constructed with a reinforced concrete deck, which was later replaced (and widened) with a steel orthotropic deck.

The Forth Road Bridge has a main span of 1,006m and was the UK's longest span and the world's fourth longest span when completed in 1964.

It represents a largely traditional design utilizing a truss stiffening girder, aerially spun (600mm diameter) parallel wire cables and vertical wire rope suspenders.

Construction of the 988m main span Severn Bridge was completed in 1966. The bridge was a highly innovative design with a streamlined box girder deck; 500mm diameter aerially spun cables and an inclined suspender system.

The use of a revolutionary box girder deck in favour of a heavier truss deck led to a very lightweight design which allowed huge material and cost savings throughout the whole structural system.

When the Humber Bridge opened in 1981 it became the longest span suspension bridge in the world with a main span of 1,410m.

It has asymmetric side spans of 530m and 280m and its design followed the innovative bridge design of the Severn Bridge, using a streamlined box girder deck, inclined suspender system and aerially spun parallel wire cables that are 700mm diameter in the main span and the longer side span, and 720mm diameter in the shorter side span.

Tension in the main cables varies along their length, becoming a maximum at the top of the shorter side span where the inclination is steepest.

The tension difference on either side of the tower is normally sustained by frictional resistance between the saddle and the cable wires but to reduce this friction and save wire in the other longer spans, the shorter side span has 800 additional wires anchored at the tower saddle.

Over the last 16 years, internal cable inspections have been commissioned at all four bridges to evaluate the condition and strength of the main cables, and the corrosion protection of all four bridges has been enhanced.

The Tamar Bridge cables are of different construction to the Forth Road, Severn and Humber Bridges and are explained separately below.

TAMAR BRIDGE CABLES

The main cables are each formed of 31 locked coil strands around 60mm in diameter with protective bitumen filler used to completely fill the voids between them. Locked coil strands are believed to have been chosen by the designer to provide superior long term corrosion resistance.

Figure 1: Original cable construction photographs

Over the years there had been a noticeable stretch of the locked coil strands due to creep of the helically arranged wires under service load.

The increase in cable sag resulted in a change to the vertical profile of the bridge and consequently, the opening of gaps between wrapping wires causing the external paint to crack, allowing water to penetrate.

As part of a structural assessment in 1996, part of the cable was unwrapped, and the outer strands were found to be in very good condition.

This helped to confirm the viability of the strengthening and widening project completed between 1999 and 2001.

During these works, the opportunity was again taken to unwrap the same section of cable, and this showed that little further deterioration had taken place.

Figure 2: Tamar Bridge cable inspection - wedging strands apart, cleaned inner strands and re-wrapping

As discussed below – intrusive inspections of the cables at Forth Road Bridge in 2004 and Severn Bridge in 2006 revealed that the internal condition of the main cables was worse than expected.

These findings prompted the Tamar Bridge and Torpoint Ferry Joint Committee (TBTFJC) to decide that the condition of the inner strands of the Tamar Bridge main cables should be assessed by wedging them apart.

Sections of both the main span and side span cables were inspected.

After unwrapping and cleaning the cables, lines of wedges were progressively driven to displace the strands and allow the surface condition of the inner strands to be examined.

Nearly every wire of every strand visible still had an intact layer of zinc galvanizing – see Figure 3.

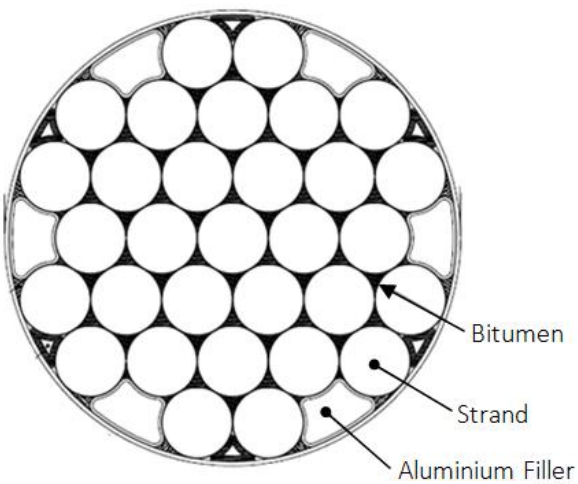


Figure 3: Tamar Bridge cable cross section

A few small areas of brown rust were observed, which were thought to have been caused mainly by damage during cable erection.

Before the wedges were withdrawn filler was replaced between the strands to replicate the original system (see Figure 3), and the various aluminium extrusions were replaced around the cable before applying a layer of Metalcoat and re-wrapping with soft galvanised wire using a purpose designed hand wrapping machine – see Figure 2.

The cable was then painted with an elastomeric paint system.

This result was in stark contrast to the intrusive inspections carried out on many other aging suspension bridge cables, where extensive corrosion and broken wires had been found.

The bitumen filler between the strands has provided outstanding corrosion protection by excluding moisture and maintaining non-corrosive conditions inside the main cables.

The existing bitumen was tightly adhered to the surface of the strands and together with the external zinc paste, wrapping wire and paint system has provided excellent protection to the main cables.

Given that the main cables were in such good condition, there had been no significant strength loss in the first 47 years of service.

It had clearly been an extremely prudent decision by the designer to fill the internal voids between the strands with bitumen.

With such positive cable inspection findings, it was determined that the only necessary improvement measure was to dehumidify the four anchorage chambers to protect the splayed main cable strands and anchor points.

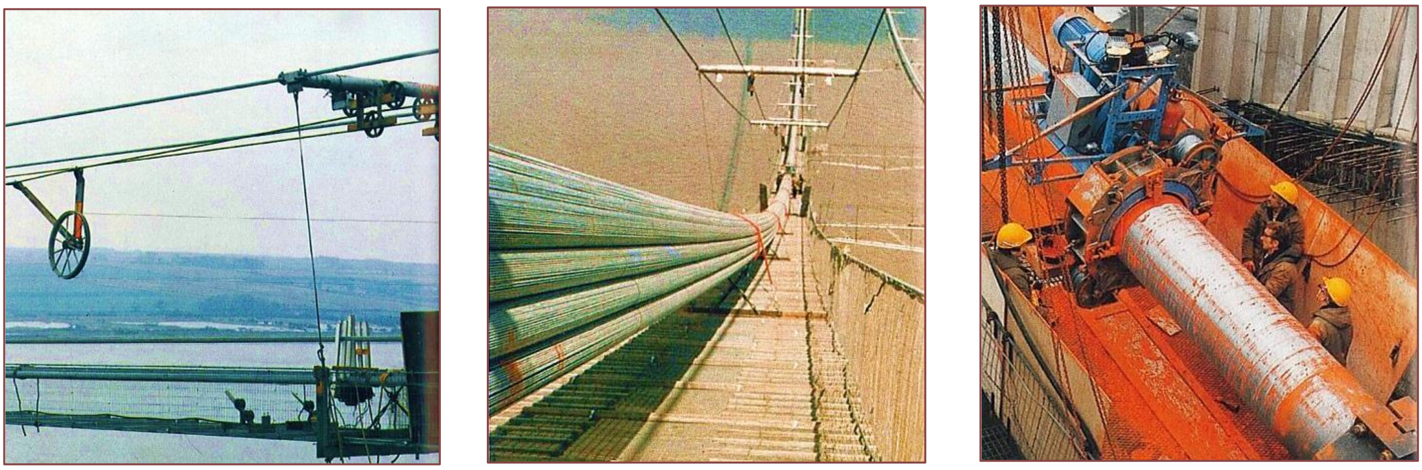


Figure 4: Humber Bridge cable spinning, wrapping and painting photographs

FORTH ROAD BRIDGE, SEVERN BRIDGE AND HUMBER BRIDGE CABLES

The main cables of the Forth Road Bridge, the Severn Bridge and Humber Bridge were constructed using the aerial spinning method, in which loops of 5mm diameter hot dip galvanized wire are drawn out across the spans by spinning wheels to form strands.

The strands were then compacted into a circular cross section and a conventional protection system of red lead paste, round wire wrapping and external paint was applied – see Figure 4.

During cable erection, the main cable wires are exposed to the elements; protected only by their hot dip galvanized coating; and the aerial spinning process can cause abrasion of the wires and damage this protective galvanizing.

In addition, cable compaction causes the wires to move across each other and this can further abrade the galvanizing, particularly on the outer strands where the wires undergo the greatest movement to form a compacted circular cross section – ready to receive the cable bands and wire wrapping.

The cable bands are tightly clamped to the cables by tensioned rods.

The cable bands were originally caulked with weather tight sealant and an opening on the underside was left un-caulked to allow water to drain out, although these openings were very small on the Severn and Humber Bridges – see Figure 5.

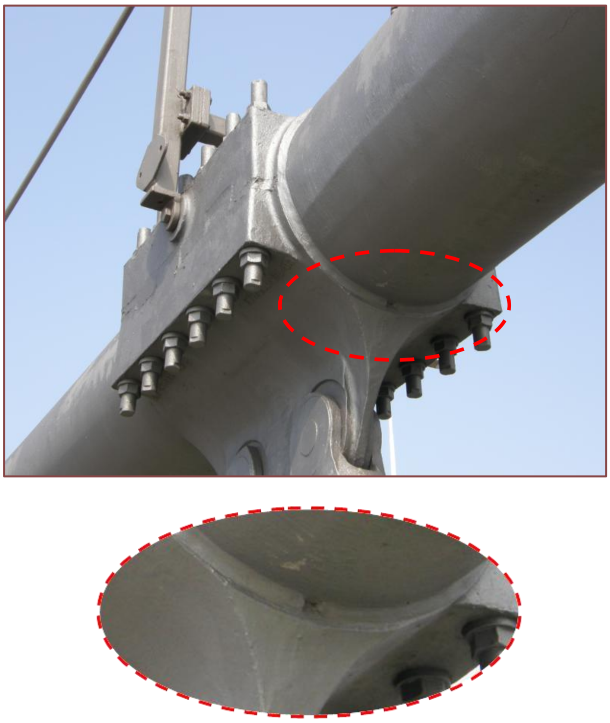


Figure 5: Humber Bridge cable band (before cable dehumidification)

The direction that wire wrapping of the cable proceeded during construction can also affect the future deterioration rate of the internal wires.

Wrapping uphill (with a few panels left unwrapped at the low points to allow water to drain out) tends to hold rain water in the cables, whereas wrapping downhill tends to exclude water.

The effect of this has been observed by the author when wire wrapping the cables of suspension bridges – following periods of heavy rain, water has continued to seep out of unwrapped panels at mid main span for several days.

FIRST INTERNAL CABLE INSPECTIONS

Planning of the first internal main cable inspections at all three bridges involved an initial cable walk inspection to establish the condition of the paint, wrapping and caulking materials; and to ascertain which panels should be internally inspected.

Relatively few external defects were recorded during the cable walk inspections on any of the three bridges, which confirmed that the main cable paint systems had been well maintained.

However, closer examination revealed paint cracks and paint blisters nearer the low points, suggesting that water was penetrating the protective layers and becoming trapped inside the cables.

Figure 6: Humber Bridge cable walk inspection

The first internal inspections at all three bridges followed the TRB's National Cooperative Highway Research Program (NCHRP) Report 534: Guidelines for Inspection and Strength Evaluation of Suspension Bridge Parallel Wire Cables (2004), with typically eight wedge lines being driven and sample wires removed from the wedge lines and replaced with a new piece of wire.

The wedge lines were inspected and wire conditions were assigned into Stages 1 to 4 as per the NCHRP Guidelines.

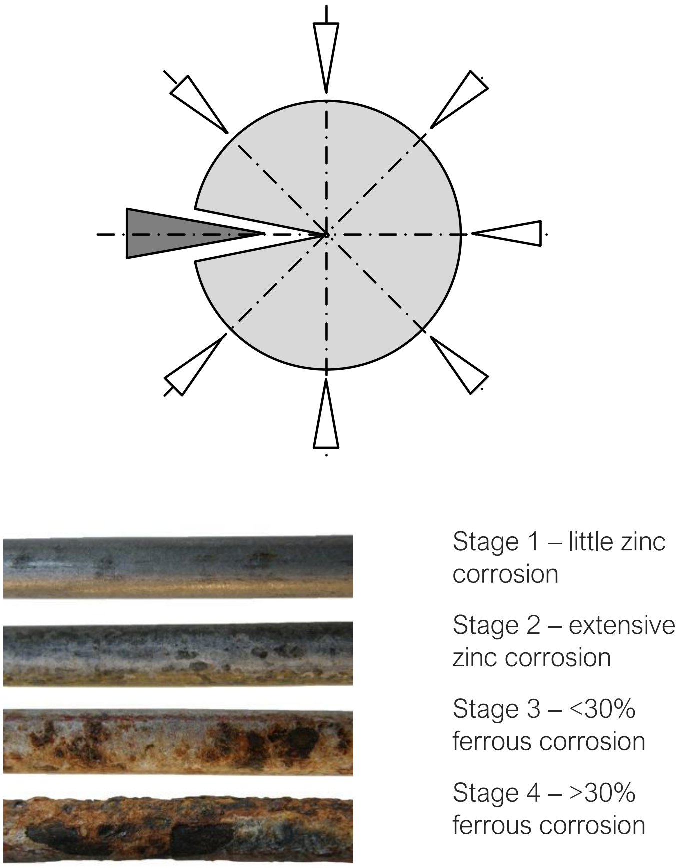


Figure 7: Cable wedging and corrosion stages

The first internal inspections at Forth, Severn and Humber all revealed that the extent of corrosion was generally worse than expected, and the most deteriorated main cable panels on all three bridges were the mid main span locations.

Probably as a result of water running down the cables and accumulating there but also because these sections of cable are in the 'splash zone', i.e. closest to the deck and therefore exposed to traffic spray.

Figure 8: Humber Bridge 2019 cable investigation – high- and low-level access platforms (photo provided by Cleveland Bridge)
Inset – Severn Bridge high level platform

Figure 9: Forth Road Bridge cable investigation photographs

At the Forth Road Bridge, broken wires were found in several panels inspected and many wires had Stage 4 corrosion – see Figure 9.

The main cable strength loss at the time of the first inspection (2004) was assessed as being between 8% and 10% but the factor of safety against tensile failure remained adequate, therefore the bridge continued to operate safely.

However, future strength loss predictions suggested that traffic restrictions might be necessary by 2019.

The most deteriorated panels at the Severn Bridge were also found to be in poor condition with many broken wires in some panels.

Many of the broken wires were Stage 3, and not the normally expected Stage 4. Consequently, the main cable strength calculations at the time of the first inspection (in 2006) produced significant strength loss but an assessment showed that with minor traffic restrictions the bridge was safe to remain operational.

At the Humber Bridge, the main cable strength loss, assessed following inspections in 2009 using the NCHRP Guidelines, was significant but modest in comparison to the older Severn and Forth Road Bridge cables.

The conclusion from these internal cable inspections was clear. That corrosion would get worse if no action was taken and the bridges could face weight restriction or premature closure.

As the first internal inspections at all three bridges had only examined a small proportion of the main cables, it was considered unlikely that the worst panel had been found. Therefore acoustic (wire-break) monitoring systems were installed to monitor the full length of the cables.

DEHUMIDIFICATION SYSTEMS

Protection of steel against corrosion by humidity control is a long-proven technique.

The relationship between corrosion rate of ferrous steel and humidity was identified by Dr W H J Vernon in 1929 and is represented in a graph, commonly known as the 'Vernon Curve' – see Figure 10.

The relative humidity (RH) inside the cables is maintained at approximately 40% – the humidity used for corrosion protection of steel in exposed coastal locations.

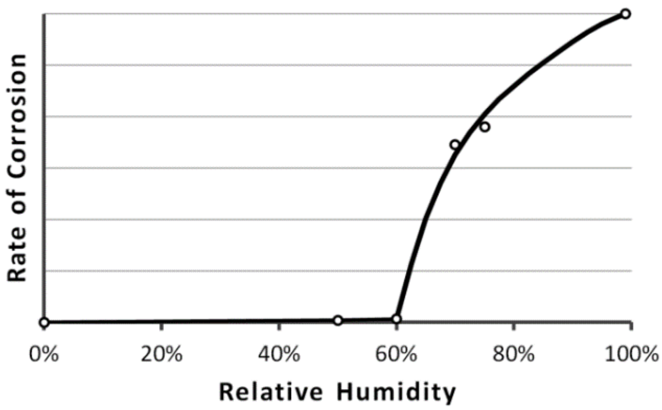


Figure 10: The Vernon Curve

The function of a cable dehumidification system is to ventilate the cables with a continuous flow of dried air, but this requires installation of an air tight and weather proof wrapping and sealing system around the cables.

The wrapping and sealing materials need to remain substantially air tight and prevent water ingress for many years for the continuous flow of dried air to effectively maintain non-corrosive conditions within the main cables.

Various wrapping and elastomeric paint systems were considered but it was decided that DS Brown's Cableguard^{TM} product would provide the best solution, as it was known to be capable of resisting internal air pressure and could be simply applied on top of the existing wire wrapping.

Its application is less dependent on environmental conditions than paint systems, which is particularly beneficial in the exposed conditions.

Longevity was another key requirement and it was considered to be more durable than paint systems, thus requiring less maintenance.

CableguardTM is supplied in rolls and applied using a 'Skewmaster' wrapping tool to achieve the required overlap, then heated to bond the layers together – see Figure 11.

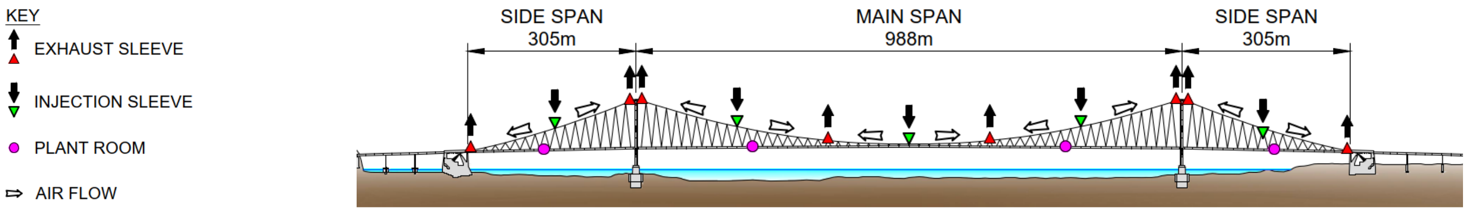
Figure 11: Cableguard^{TM} wrapping and heating

An inflatable heating blanket was developed by the contractor at the Severn Bridge to produce best results, as it could adapt to the slightly non-circular cable shape of the cables.

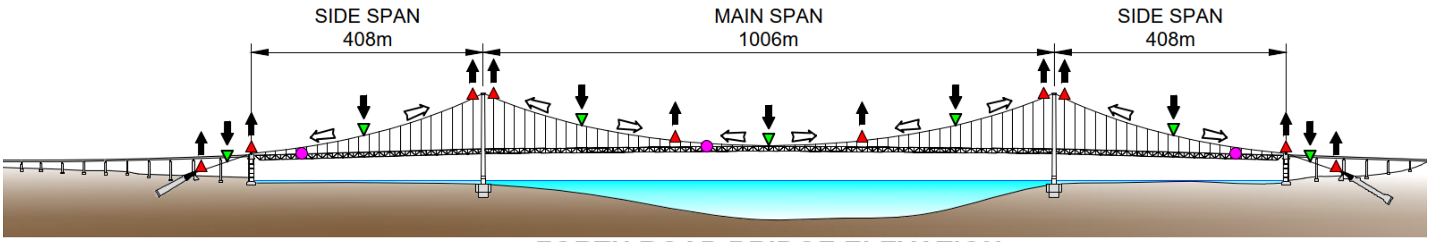
Extensive wrapping and sealing trials were specified, both in the yard and on low-level cable panels to train the Contractor's workforce and develop approved methods for all of the wrapping and sealing activities. These trials proved to be very useful in establishing high quality standards from the outset.

Durable air tight details were developed for sealing the ends of cable bands to provide the necessary air-tightness and weather protection.

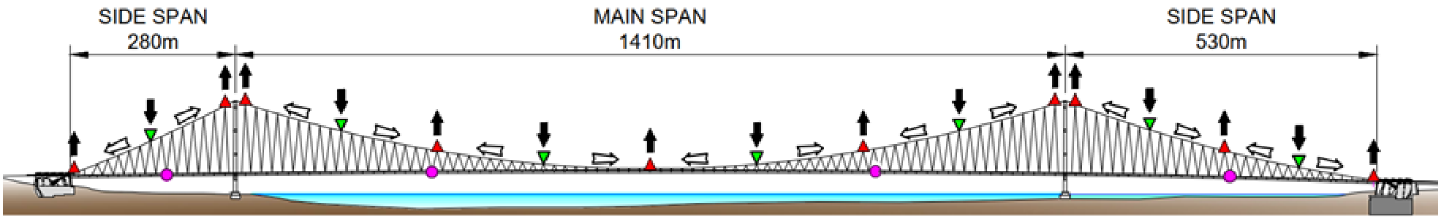
Figure 12: Cable wrapping (left) and cable band sealing (right)



SEVERN BRIDGE ELEVATION



FORTH ROAD BRIDGE ELEVATION



HUMBER BRIDGE ELEVATION

Dried air is produced in sealed plant rooms and blown along pipe work by fans to injection points sealed onto the cables.

The dried air passes inside the cables through the small gaps between the wires, picking up moisture before being exhausted into the atmosphere.

The plant rooms on all three bridges were designed to use proprietary off-the-shelf equipment to simplify future maintenance, reduce capital cost and long term running costs.

Energy efficiency was also achieved through passive heat recovery to reduce the energy needed to run the dehumidifiers.

On the Forth Road Bridge, the plant rooms were conveniently located within the gap between the road deck and the cantilevered footways – see Figure 13.

This allowed the plant rooms to be delivered preassembled and fully commissioned for connection to pre-installed electrical supply cables and air pipes.

This greatly simplified installation and allowed the plant rooms to be fully tested and commissioned in the shop.

The plant rooms on the Severn and Humber Bridges were conveniently located within the box girder deck, which allowed lightweight fibreglass panelled plant enclosures to be used.

The injection points on the main cables are supplied by fans controlled by an inverter speed controller and pressure sensors to consistently maintain the required pressure.

A high degree of air filtration is required to prevent carryover of salt, debris or other air borne contaminants which could ultimately clog the interstices between the wires and prevent continued operation of the system with no simple means of rectification.

On all three bridges a Supervisory Control and Data Acquisition (SCADA) system is used to monitor and control the systems via a dedicated website.

Sensors provide monitoring data for the plant rooms, injection and exhaust positions and weather conditions.

A durable monitoring system is important because it indicates whether the system is operating efficiently and effectively and maintaining reduced

Figure13: Forth Road Bridge and Humber Bridge cable dehumidification plant rooms

humidity inside the main cables. Monitoring data also provided a quantifiable record of initial drying progress following commissioning.

The initial drying process is when the system removes water trapped in the main cables and reduces humidity within the cables to a non-corrosive level.

The RH and air flow are then adjusted to reduce energy use and efficiently maintain non-corrosive humidity levels within the cables. This also reduces the future maintenance on dehumidifiers, fans, filters and other components.

The successful operation of all three cable dehumidification systems is measured by charting humidity levels within the main cables over time – see Figure 15.

Temperature and humidity is measured at each injection and exhaust point, and the data logged on the SCADA system.

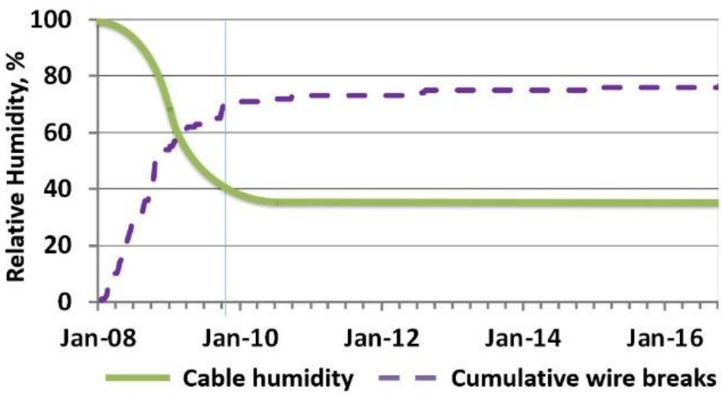


Figure 14: Reducing RH v cumulative wire break graph

This data is available for review at any time, either locally or via the website.

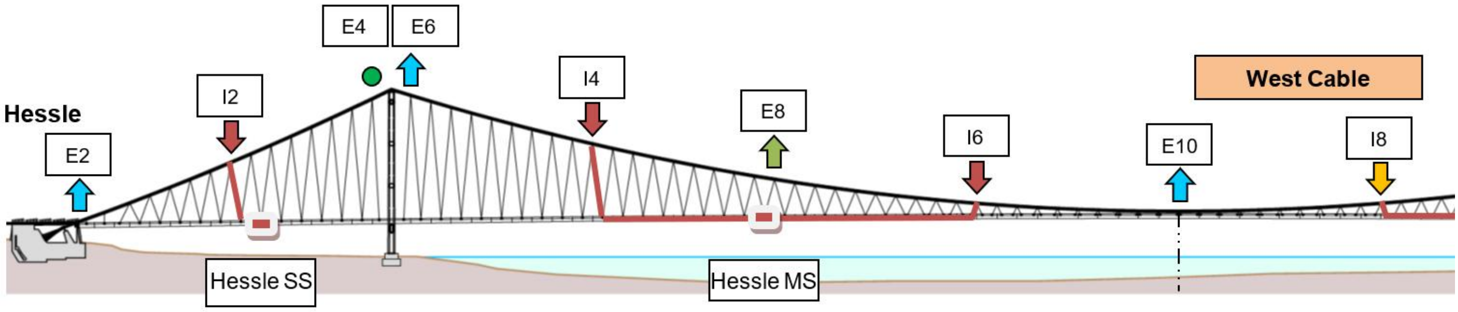
After cable dehumidification was installed on the three bridges, the frequency of wire breaks detected by the acoustic monitoring systems reduced dramatically – see Figure 14.

A diminishing main cable factor of safety is the primary concern for bridge owners and is the reason that cable dehumidification systems were installed at all three bridges.

Subsequent cable inspections, including the most recent internal cable inspections in 2017 at the Severn Bridge, 2018 at the Forth Road Bridge and 2019 at the Humber Bridge; have further verified that the cable dehumidification systems are successfully protecting and greatly extending the life of the main cables.

These results have confirmed that the presence of water was driving the deterioration process and the traditional protective system of red lead paste, wire wrapping and conventional paint did not provide the expected long term protection.

The encouraging results of follow up internal inspections over the 10 year period after installing cable dehumidification, together with wire break monitoring data have also confirmed that protecting the main cables by installing cable dehumidification systems was an extremely prudent decision by the three bridge owners – Forth Estuary Transport Authority / Transport Scotland, Severn River Crossing / Highways England and Humber Bridge Board.



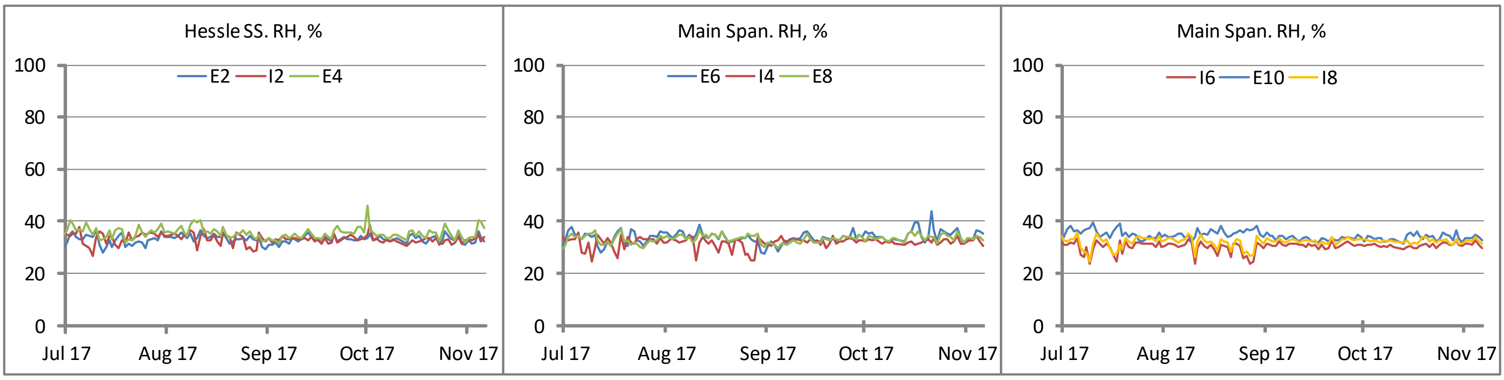


Figure 15: Sample Humber Bridge cable dehumidification monitoring graphs

The authors wish to thank the owners of all four bridges for their approval of this article.

GEOTECHNICS AND BRIDGE PROJECTS

(DESIGN AND CONSTRUCTION OF BRIDGE FOUNDATION SYSTEMS)

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INTRODUCTION

In this article for e-mosty magazine we are going to provide a brief overview of some aspects that must be considered in a bridge project from a geotechnical standpoint.

For a geotechnical engineer a great challenge arises when they have to face a new bridge project.

Among other things, that is because there is a strong relationship between the structural response of the bridge and the geotechnical characteristics that you may find on site.

The geotechnical engineer must accurately consider the characteristics and stages involved in the construction process to be carried out throughout the project.

To choose a particular type of foundation for a bridge structure will not always be a straightforward task because there are different aspects that must be considered altogether in the project.

The foundation response of a segmental bridge will not be the same as the response of a cable stayed bridge or an integral bridge, that is because according to the effect of each set of acting loads in every phase in conjunction with its structural characteristics, there will be a specific bridge response.

It is important to emphasize that the structural and geotechnical engineer must be able to work together to satisfy the project requirements as a whole.

A good example of integration between structure, geotechnics and architecture is "La Salve Bridge" in Bilbao, Spain.

This bridge serves as a route into the Bilbao city that blends and integrates perfectly into the Guggenheim Museum (Figure 1).

Figure 1: La Salve Bridge. Bilbao, España

FOUNDATION DESIGN IN A BRIDGE PROJECT

According to the geotechnical condition, loads, type of structure, seismicity and performance requirements, there will be some typical configurations of foundations that could be used in a bridge project (Figure 2).

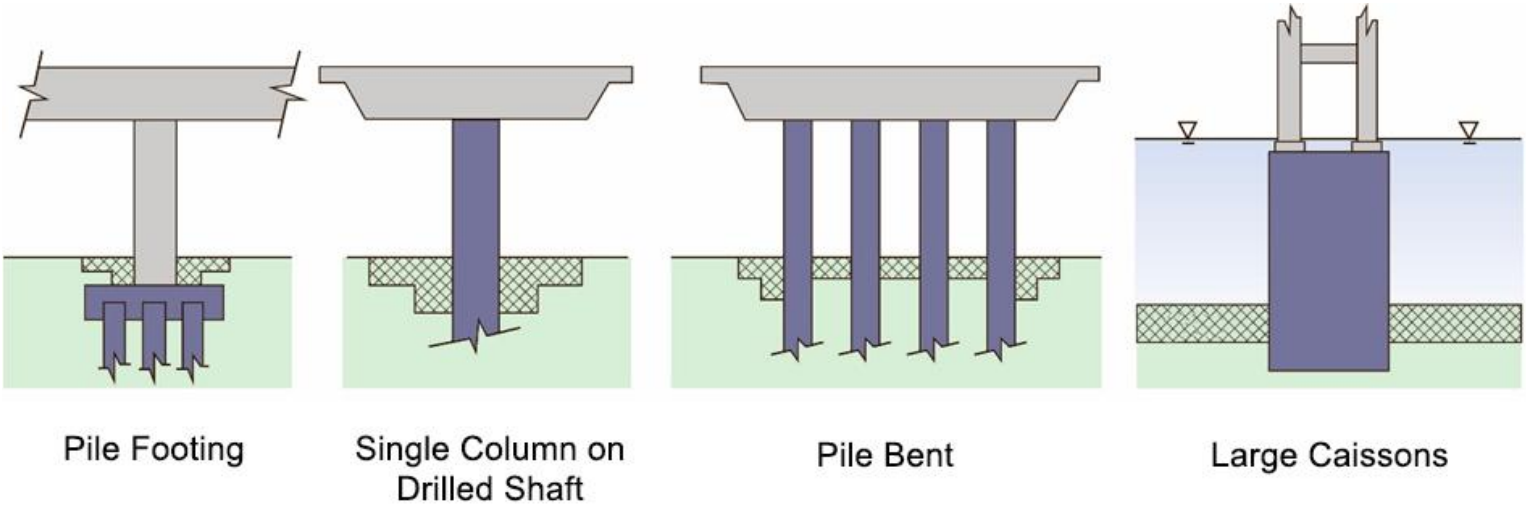


Figure 2: Typical Structural Forms for Bridge Foundation Systems

In order to have a better understanding of the relationship between the structural response of the bridge and the geotechnical condition, let us review some aspects that must be taken into account when selecting a soil-foundation system for a bridge project.

LOCATION AND TYPE OF STRUCTURE

The bridge engineer has a much wider choice in foundation design compared to other type of structures, and can often dictate the magnitude of foundation loading by choosing the span length to suit the topographical and geological conditions.

A typical "rule of thumb" (according to the scope of the project) is to proportion the span length so that the cost of the foundation roughly balances the cost of the superstructure of the bridge.

In most cases the bridge engineer has little opportunity to choose the location of the structure to take advantage of good ground conditions.

For example, highway or rail bridges are located to suit connections with existing roads or railways and sites of over-water bridges are chosen to give the shortest length of crossing.

Likewise, there are other sites where the waterways have been stabilized by man-made features.

MAGNITUDE AND DISTRIBUTION OF LOADS

Foundation loadings for bridges are very different compared to those that are typically found in buildings. Imposed loads can be dominant and can be as much as half the dead load on highway bridges and two-thirds of the dead load for railway bridges.

Imposed loadings from traffic are moving loads and can exert considerable longitudinal traction forces on the bridge deck.

Longitudinal forces are also caused by shrinkage and temperature changes in the bridge deck, while transverse forces can be caused by wind loadings, current drag, wave forces and ship collisions in the case of rivers or estuary crossings.

On the other hand, earthquake forces can be transmitted by the ground to bridge supports from any direction, and these can be critical for high level structures or for piers in deep water where the mass of the displaced water must be added to that of the pier body.

In addition to working loads from traffic, there could be a rapid application of load to the foundations at the construction stage, for example when complete spans are assembled at ground level and lifted or rolled into place to the piers.

The foundations of intermediate piers for bridges on land are required to withstand forces from the following causes:

- Dead load from self-weight of piers, beams, deck, pavings and services.
- Imposed loads from traffic (combinations of loaded and unloaded spans).
- Traction forces from traffic, longitudinal to bridge axis.
- Longitudinal forces at the top of the pier from effects of shrinkage, temperature and creep in superstructure.
- Longitudinal, transverse and vertical forces from wind and earthquakes.
- Unequal horizontal earth pressure (for piers on sloping ground or from surcharge loading by adjacent embankment).
- Impact from vehicle collision.

DESIGN TOPICS

To carry out a typical foundation design, the geotechnical engineer will be in charge of estimating the vertical and lateral capacity of the soil-foundation system according to the information obtained from the geotechnical report, and using well known expressions or correlations to estimate the foundation bearing resistance based on analytical methods or using semi-empirical expressions derived from field tests (SPT, CPT, DMT, etc).

It is often thought that the only foundation system solutions available for bridge structures are pile groups, bent piles or caissons.

In spite of the fact that these types of foundations are considered as the preferred solution for complex geotechnical conditions, there are several documented experiences available of bridge projects supported by shallow foundations (*Report FHWA-SA-02-054*).

However, in several cases these solutions are combined with soil improvement techniques before construction in order to reach the required bearing capacity of the soil-foundation system.

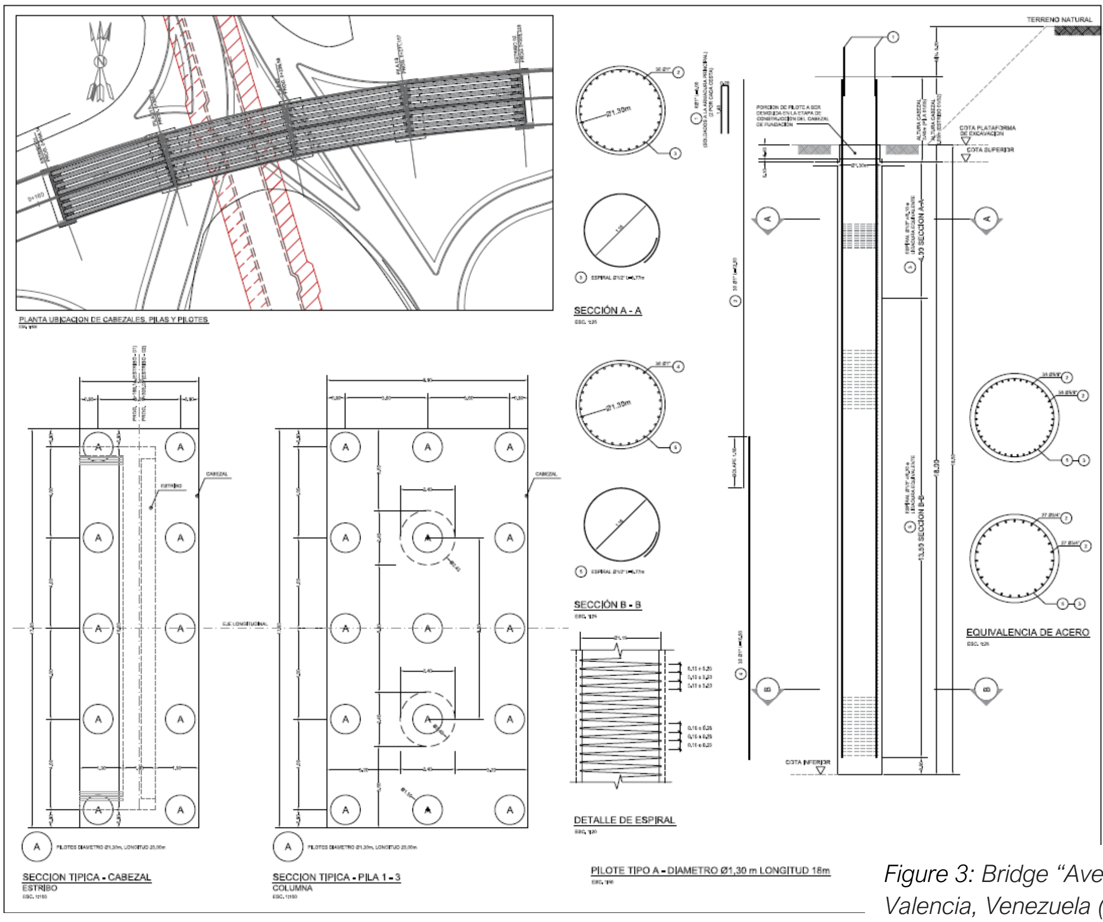


Figure 3: Bridge “Avenida Las Ferias”. Valencia, Venezuela (2015). Details of drilled shafts for piers and abutments

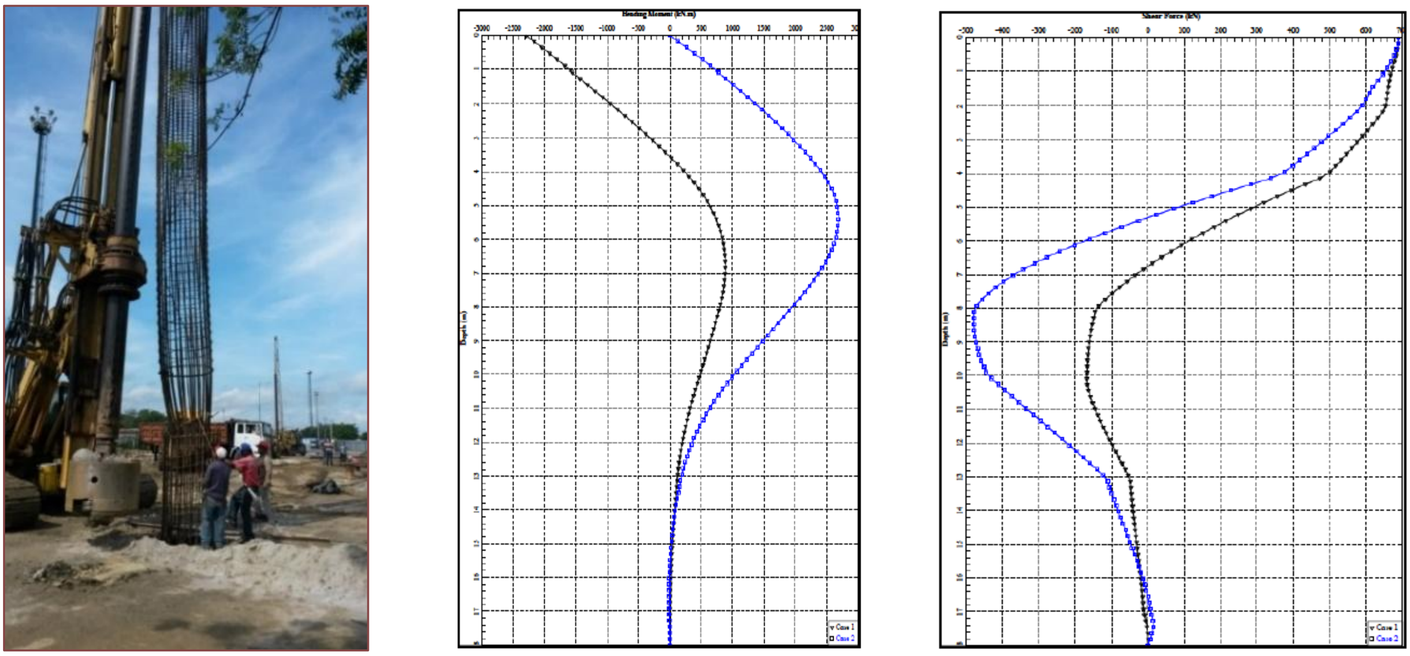


Figure 4: Bridge "Avenida Las Ferias". Valencia, Venezuela (2015). (Piles subjected to lateral forces. Maximum depth 19 meters). 4.a) Placing of reinforcing steel cage for shafts. 4.b) Results of typical response of shafts against lateral forces.

For pile foundations there are other aspects that must be taken into account, for example: length, tip and skin capacity, downdrag, lateral response, group effect against vertical and lateral loads, relationship between the stiffness of the pile and the pile-cap, influence of liquefaction effects, among others.

When the bents are supported by a single pile it will be extremely important to have an accurate estimation of the pile behaviour against lateral and moment loads.

The p-y curves approximation are extremely useful to estimate the lateral response of the piles, additionally in the last years several computational tools have been developed in order to carry out this type of analysis.

An example of laterally loaded piles is shown in Figures 3 and 4 (Bridge "Avenida Las Ferias", 2015). In this project, the piles were designed for vertical and lateral loads in order to withstand the typical bridge loads, e.g. dead, live, traffic and seismic loads.

The geotechnical and structural design of the pile groups for piers and abutments was carried out following the AASHTO LRFD Bridge requirements (Seismic design category D).

Pile group solutions should be considered in cases where foundation loads make single shaft foundations unusually large and particularly costly. As illustrated in Figure 5, large overturning moments are most effectively resisted using groups of piles due to the efficient moment resistance produced by the axial resistance of widely spaced piles within a group.

Because of the need for large, heavy equipment to install single pile foundations larger than 2.40m in diameter, groups of smaller diameter shafts may be more cost effective in many circumstances.

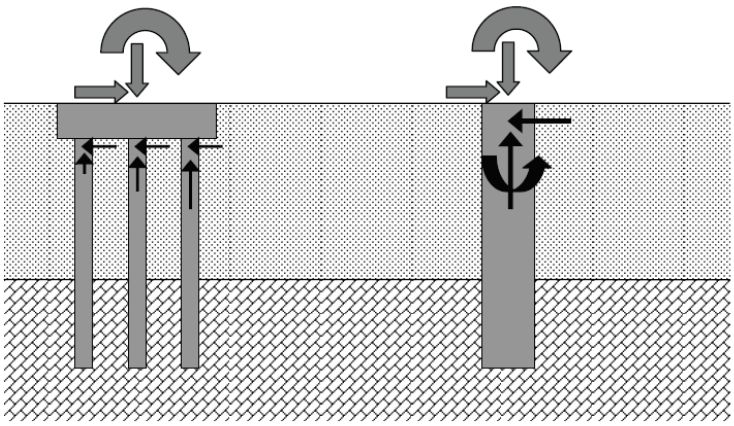


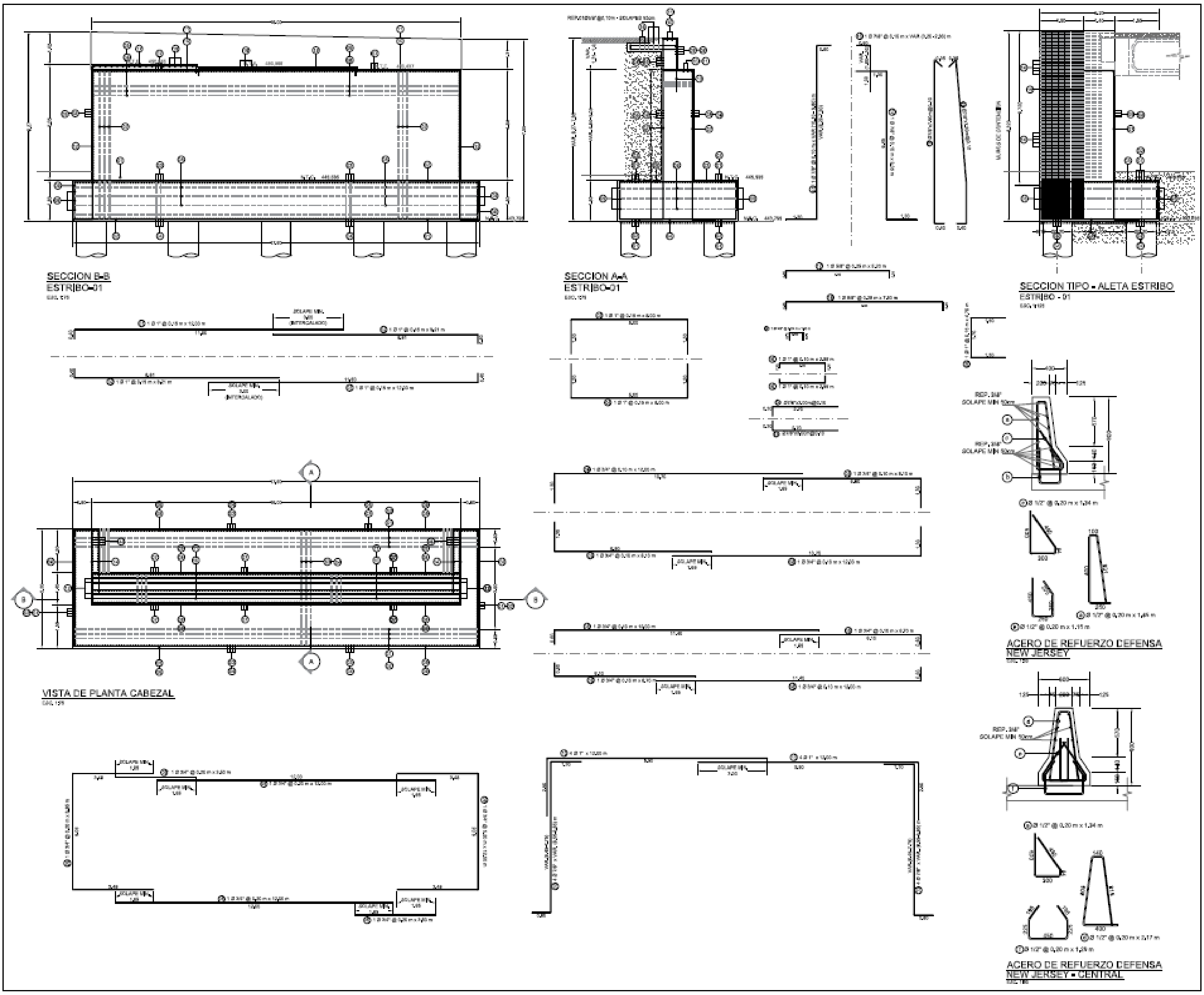
Figure 5: Group versus Single Shaft

Group foundations are less advantageous where the cost or difficulty associated with construction of a pilecap may be significant. For over-water foundations, the cap construction can be a major expense and more time-consuming to construct. In addition, scour may be less severe with a smaller footprint of a single shaft compared to a group.

At close spacings, the sequencing of construction operations must be planned so as to avoid the potential for communication between shafts during excavation and concrete placement. Advancement of a casing ahead of the excavation to avoid a reduction in lateral stress and/or loosening of the ground around piles is one means to avoid these adverse effects in some types of materials.

In any case, group effects must be considered at a centre to centre spacing of less than 4 diameters for axial resistance and less than 5 diameters for lateral resistance. (*The definitive centre to centre spacing will be according to the type of soil and load transfer mechanism of the pile group*).

In Figure 6 it is shown a pile group solution for a bridge project (Bridge “Avenida Las Ferias”, 2015). The typical centre to centre spacing for these shafts was between 2.5D and 3D, therefore, it was required to estimate an efficiency factor against vertical and lateral loads following the AASHTO LRFD Bridge requirements in order to estimate the actual capacity of the shafts affected by group effects.



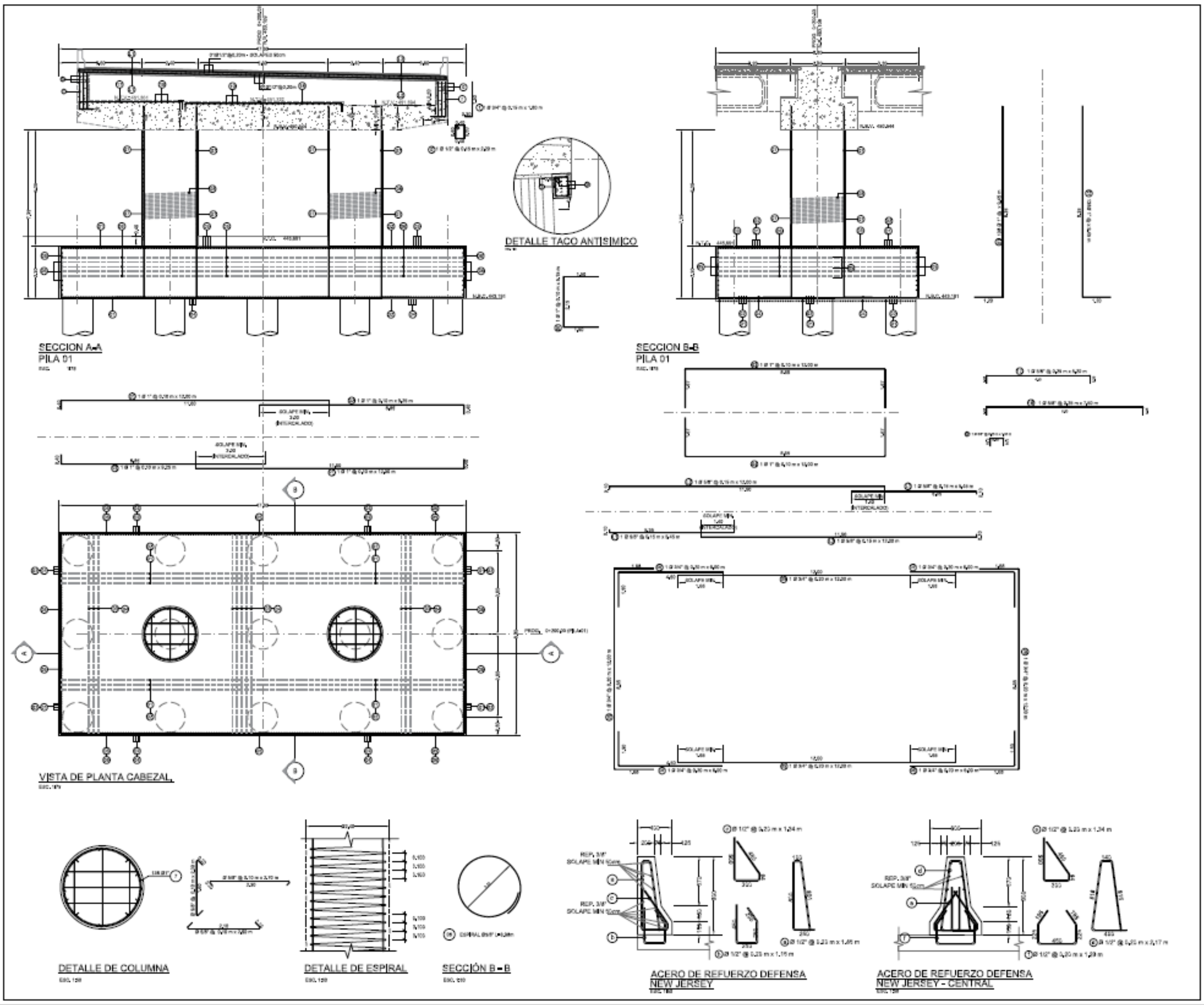


Figure 6: Bridge "Avenida Las Ferias". Valencia, Venezuela (2015). (Details of shaft groups subjected to vertical and lateral forces. Typical Diameter = 1.3 m). 5.a) Drawings of pile groups for abutments (10 shafts). 5.b) Drawings of pile groups for piers (15 shafts).

OVERALL AND DIFFERENTIAL SETTLEMENTS ASSESSMENT

The geotechnical engineer must have a detailed description of the characteristics of every construction stage. According to the load pattern there will be a different response on the bridge substructure at each phase.

The relationship between axial and bending forces will vary throughout the bridge construction, therefore, having estimated the magnitude of these variables at each stage will be vital to control the foundation stability.

To illustrate the relationship between the construction phases and the geotechnical response, let us describe an example of foundation behaviour in terms of settlements for a typical construction sequence in a 40m span balance cantilever bridge project. Each pier is supported by a strip foundation over variable geotechnical conditions.

The feasibility of limiting the differential settlement of the bridge deck is made possible in this case by obtaining detailed information of the variations in soil density at a number of points along the viaduct location, and by precise levelling of the piers and bearings at intervals during construction.

Knowing that pier B had settled by 8 mm when only 50% complete, compared to a final settlement of 1 mm after completing pier A, the bearing on pier B is set 10 mm high after completing the pier. Then, by the time the cantilevers over both piers are finished, at stage 4, the differential settlement between the bridge bearings is 20 mm compared to 30 mm between piers (Figure 7).

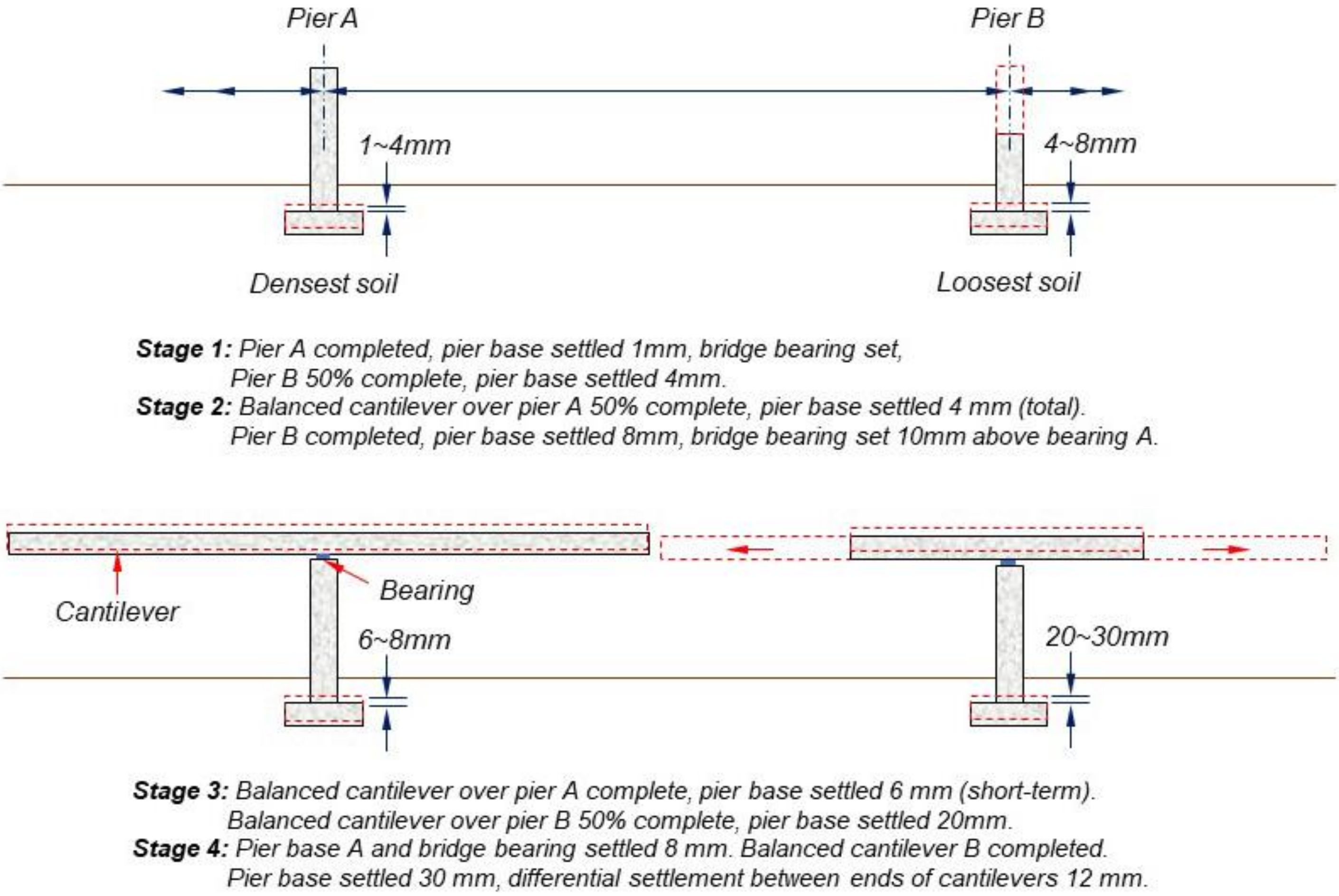


Figure 7: Total and differential settlements of continuous girder bridge during construction. (First Stages)

The two adjacent cantilevers are joined together at this stage.

After this only the dead load of the deck in the short term and the imposed load in the long term cause differential settlement of the combined deck and girders between the bearings.

In the short term this differential movement is calculated to be 15 mm (stage 5) and in the long term it is 25 mm (stage 6) compared to a final differential settlement between the pier foundations of 60 mm.

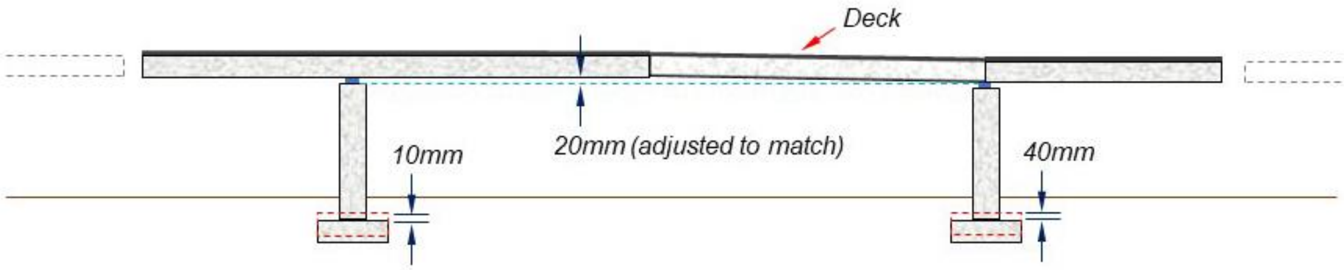
Finally it is reported an angular distortion of 1 in 1600 estimated from the differential movement between deck bearings (25 mm).

The bridge engineer must be in charge of validating if this differential movement could be accommodated in the superstructure of the reinforced concrete bridge (Figure 8).

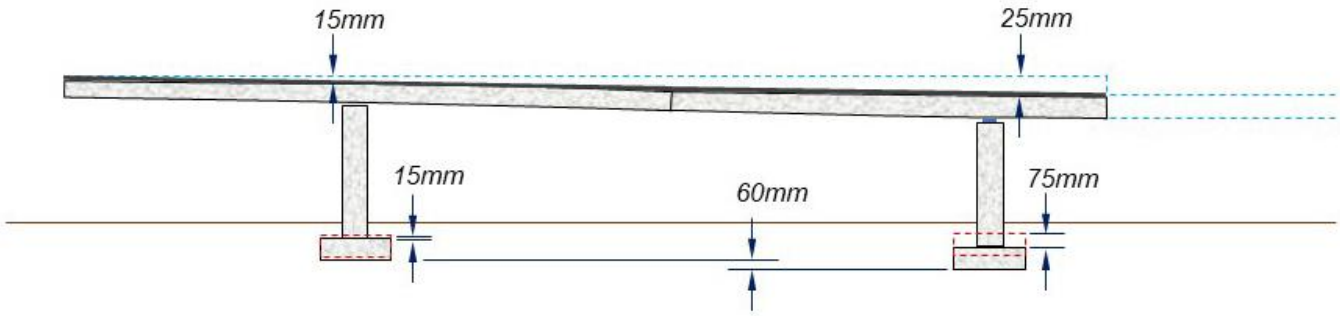
It is important to emphasize the difficulty of making precise forecasts of settlements in variable soil conditions.

However, by working through the stages of construction, the bridge designer can obtain a reasonably close estimate of the maximum differential settlement which will be experienced in the bridge spans over the life of the structure.

Minimizing the effects of differential settlement can be greatly simplified if it is possible to jack the girders and adjust to level before joining them together.



Stage 5: *Deck constructed from pier A to pier B. Pier base A settled 10mm, pier B settled 40mm. Differential settlement between bridge bearings 20mm (1 in 2000). Differential settlement of deck between pier A and pier B is 15mm (1 in 2700).*



Stage 6: *Long-term dead load of bridge with allowance for long-term imposed load. Deck above pier base A and pier base settlement is 15 mm. Deck above pier base B settlement is 40 mm (total). Differential setlement of deck from A to B is 25 mm (1 in 1600). Final settlement of pier base B is 75mm.*

Figure 8: Total and differential settlements of continuous girder bridge. (Last stages and in long term)

RELATIONSHIP BETWEEN DECK BEHAVIOR AND SETTLEMENTS

Bridges with continuous spans can be sensitive to the effects of differential settlements between foundations.

Additionally, the calculated total and differential settlements must be considered in relation to the riding quality of the road surface.

Critical points are the junction between the bridge and approach embankments and joints between fixed and link spans (Figure 9).

Most of the settlements due to the weight of the piers are likely to be completed before the construction of the superstructure.

In those cases where the deck and supporting girders consist of assemblies of prefabricated elements built out from the piers, much of the settlement from the superstructure dead load may have taken place before the joining of the two ends of the cantilevers.

On the other hand, where the deck is constructed *in situ* on temporary supports, nearly all the dead load is applied to the foundations instantaneously as the supports are removed.

In the case of spread footings on stiff over-consolidated clays, it is typical that the immediate settlement is about half of the total, which gives scope for considering the effect of the construction programme on the amount of total and differential settlement at each stage of construction.

Finally, long-term settlements due to slow consolidation of soils or creep in rock may be capable of being accommodated by creep in the reinforced concrete or steel superstructure.

Figure 9: Examples of deck joints. (Figure 9a) Conventional bridges (left), (Figure 9b) Cable Stayed Bridge (right)

FOUNDATION DESIGN FOR SEISMIC LOADINGS

Current codes require a specific bridge performance against seismic forces.

To fulfil these requirements, the structural engineer must be able to consider the stiffness of the soil-foundation system in order to have a more reliable response of the structure.

In this phase it is highly recommended that both geotechnical and structural engineer work together to determine the parameters to be considered in the dynamic analysis.

In Figure 10 a typical representation of a bridge model used to carry out a dynamic analysis is shown.

In most of the current seismic codes, there are two general approaches to assess the seismic response of the bridge, i.e. force or displacement based methods.

According to extensive research it has been proven that displacement based design methodologies for bridges are recommended especially for long bridge projects.

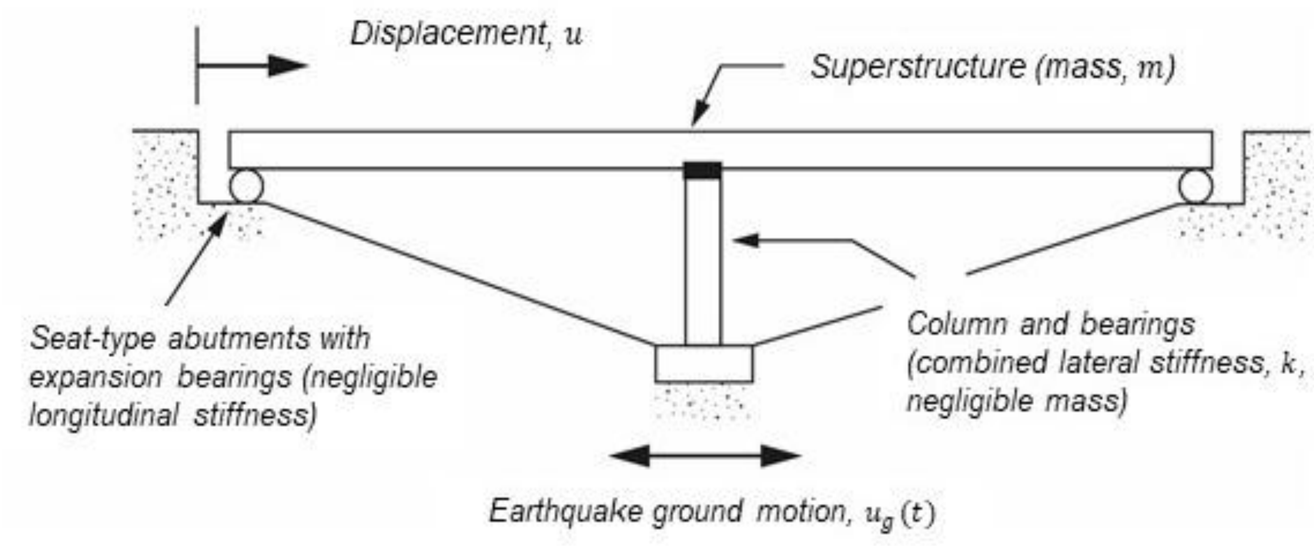


Figure 10: Two-span bridge subjected to longitudinal earthquake ground motion

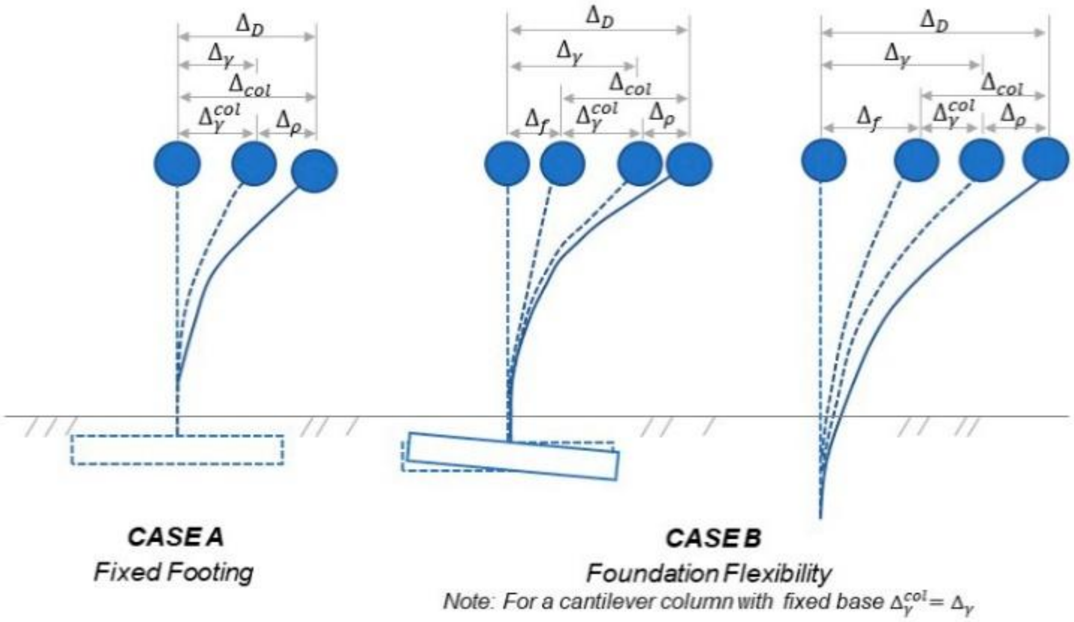


Figure 11: Effects of foundation flexibility for a single column pier (Caltrans, 2013)

However, in both cases it will be required to consider the dynamic stiffness and the damping of the soil-foundation system to assess the global response of the bridge because the soil-foundation system will be an important source of energy dissipation for the structure.

Information obtained from geophysical tests will be useful to characterize the dynamic response of the soil, however, one of the most important aspects of this analysis is that the design engineer will be able to consider the soil-structure interaction mechanisms in the global response of the bridge.

The foundation flexibility will have an important influence in the global structure displacement Δ_D (Figure 11).

Earthquakes can cause severe design problems for deep-water piles because the forces exerted at high level on the bridge superstructure combined with the forces on the pier body tend to produce high overturning moments at base level.

The mass of water displaced by the pier must be added to the mass of the pier itself, therefore, the eccentric loading on the pier base can be very large and could necessitate a larger base dimension to control the response of slender piers.

Ground shaking can cause liquefaction of loose to medium-dense granular soils. In some cases pile foundations, or ground treatment to densify a loose soil deposit may be required to support the pier. Some examples of bridges over water are shown in Figure 12 and Figure 13.

Examples of bridges over water. Figure 12 ↖: Bridge of Azarquiel, Toledo, España *Figure 13 ↗: Vasco da Gama Bridge, Lisbon, Portugal*

Foundations may fail in a number of different ways, some of these geotechnical in nature and some are structural (Figure 14).

<u>Typical spread footings and pile caps structural failure modes are:</u>

1. One-way shear failure (beam shear failure)

2. Flexural yielding of reinforcement (on top or on the bottom of the footing or cap)

3. Joint shear failure

4. Anchorage pull-out, either of the column or of piles

5. Failure of the adjacent piles, either in compression, tension, flexure or shear.

<u>And for deep foundations typical structural failure modes include:</u>

1. Flexural yielding

2. Tension yielding

3. Shear failure

4. Anchorage/connection failure (pile-to-cap or shaft-to-column)

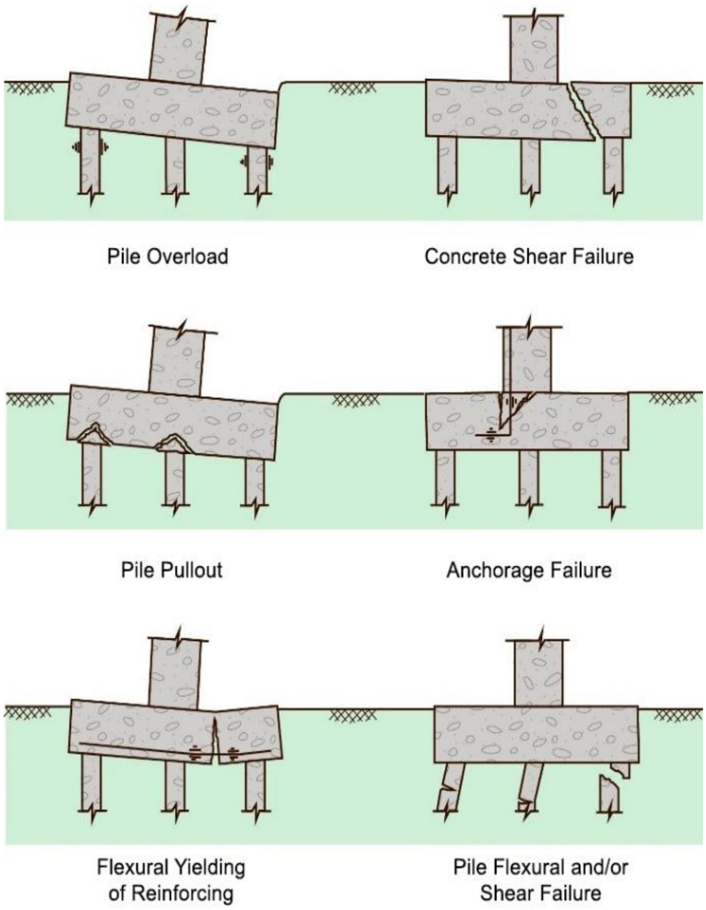


Figure 14: Typical failure mechanisms in piles and pile caps

Preventing failure from occurring in the foundation is one of the precepts of capacity design, therefore, in capacity-protected design, all of these failure modes must be avoided.

There will be some specific design situations in bridge projects where the foundations are allowed to move laterally in order to promote the rocking effect, especially for high rise bents and towers where caissons over group of piles have been an innovative solution that has been successfully used in several important projects (Figure 15).

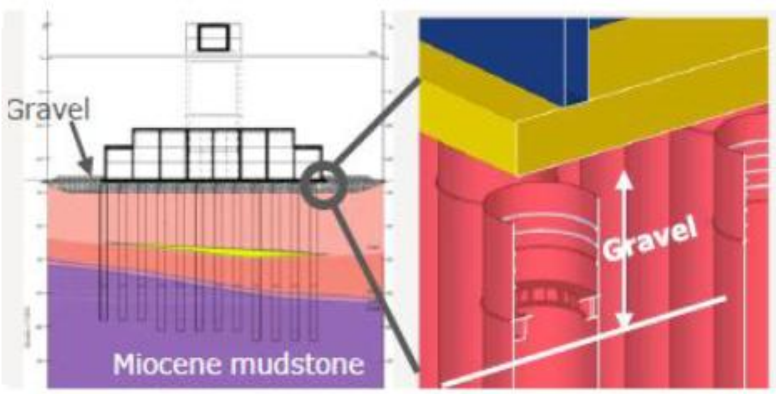


Figure 15: 1915 Çanakkale Bridge. e-mosty Magazine. Issue March 2019

INFLUENCE OF SCOUR IN FOUNDATION DESIGN

Foundation types that are susceptible to scour are usually deep foundations. Thus one of the primary considerations is the identification of the soil resistances that are likely to be lost due to scour.

These can include passive resistance around pile caps and resistance over the upper lengths of piles where soil may have been removed.

Also where soil is alternately being removed and later re-deposited around the foundation, the designer should consider using reduced stiffness and strength parameters since this soil will not be compacted around the foundation.

Such soil will have a lower lateral resistance immediately after the foundation was driven or placed (Figure 16).

Scour is often handled as a secondary case where the extremes of lateral support around a foundation are considered relative to the earthquake loading effects.

Since the worst case scour is itself an extreme event and is not likely to occur simultaneously with the design earthquake, the maximum scour condition is not usually combined with earthquake effects.

LIQUEFACTION AND BRIDGES

Soil liquefaction is a phenomenon in which a cohesionless soil deposit below the groundwater table loses a substantial amount of strength due to strong earthquake ground shaking.

The reason for strength loss is that cohesionless soils tend to compact during earthquake shaking and in saturated or nearly saturated soil this tendency causes the pore water pressure in the soil to increase.

This pore water pressure increase in turn, causes a reduction in soil strength and in stiffness.

Figure 17 shows the collapse of the Showa Bridge in the 1964 Niigata, Japan earthquake due to liquefaction induced lateral spreading of the bridge piers.

Recently deposited (i.e., geologically young) and relatively loose natural cohesionless soils and uncompacted or poorly compacted cohesionless fills are susceptible to liquefaction. Loose sands and silty sands are particularly susceptible.

Loose low plasticity silts and some gravels also have potential for liquefaction. Liquefaction has been perhaps the single most significant cause of geotechnical-related damage to bridges from past earthquakes.

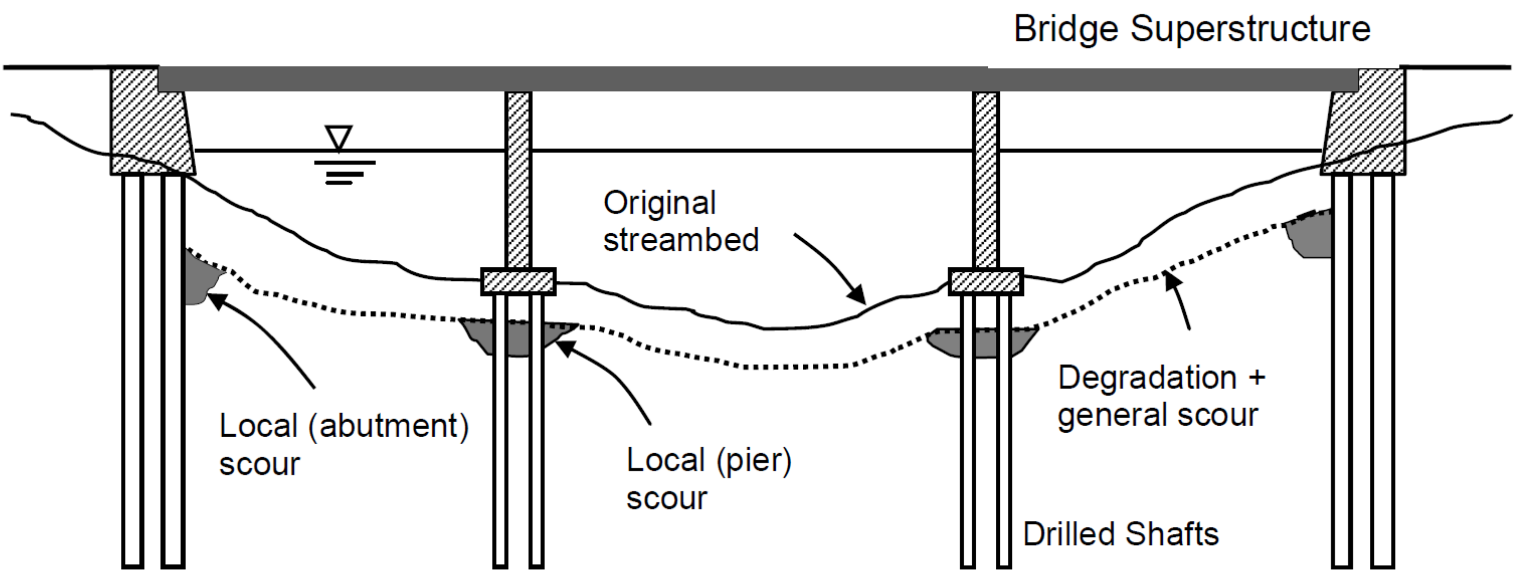


Figure 16: Components of Scour Affecting Bridge Supports on Deep Foundations

Figure 17: Collapse of the Showa Bridge in the 1964 Niigata, Japan Earthquake

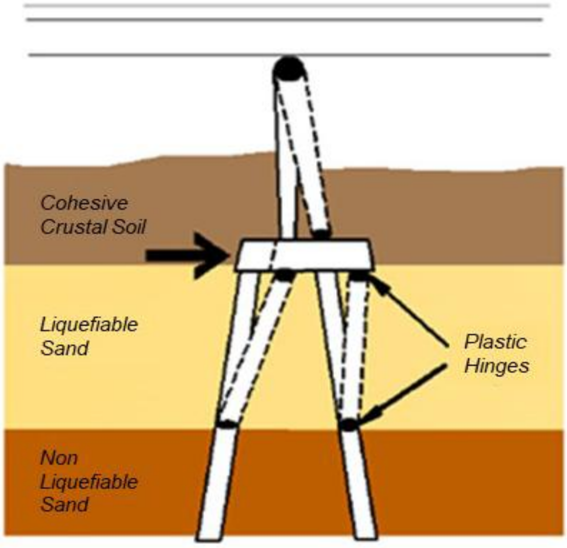


Figure 18: Landing Road Bridge Lateral Spread (Keenan, 1996)

Most of this damage has been related to the lateral movement of soil subsequent to liquefaction at bridge abutments. However, cases involving the loss of lateral and vertical bearing support of foundations for bridge piers have also occurred.

An important case history of liquefaction on bridges is the lateral spreading that occurred at the site of the Landing Road Bridge during the 1987 Mw 6.3 Edgecumbe (New Zealand) Earthquake.

A liquefied 13ft (4m) thick loose sand layer moved about 6.5ft (2m) toward the river, carrying along a non-liquefied 5ft (1.5m) thick clayey silt layer. After the earthquake, soil was mounded up behind the piers in what was apparently a passive failure.

Subsequent trenching found failure surfaces and disturbed failure masses of soil confirming the occurrence of passive failure in the non-liquefied crust as it was driven against the buried piers and pile cap.

The passive forces were found to be of the order of 10 times the estimated drag force exerted on the pile group by the liquefied sand (Berrill et al., 1997).

Cracks in the piles suggested plastic hinges in the piles were on the verge of forming, as shown schematically in Figure 18.

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BIM FOR BRIDGE CONSTRUCTION

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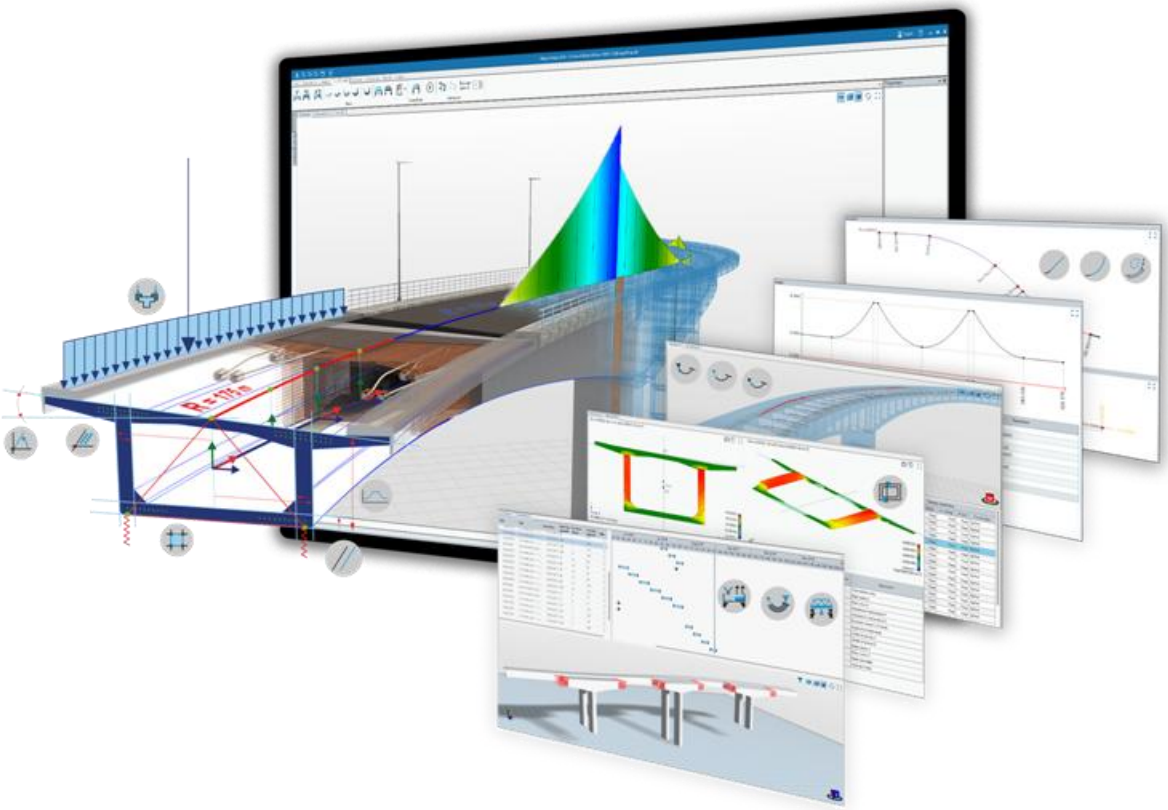

Figure 1: BIM tailored for bridge engineering

INTRODUCTION

BIM is generally conceived as overall strategy for coordinating all required works arising during design, construction and operating phases of structural objects.

This goal is achieved by using an integrated digital model (BIM model) of the structure, and procedures directly communicating with it in all task settings throughout planning, construction and subsequent lifetime.

The aim is to essentially ease and accelerate the processing by avoiding errors due to multiple and redundant data entry as well as to improve the overall quality.

The effectiveness of the BIM process is very much dependent on its consistent application in different use cases throughout the design and construction time and later.

But in the bridge construction industry, this vision of the BIM process becoming a fully integrated procedure throughout the structure's lifetime is currently often piecemeal and not yet state of the art.

BIM IN BRIDGE INDUSTRY

What is the reason for the fact, that the bridge sector is lagging the building industry with respect to the use of BIM technology, although the number of structural components and data to be managed in building projects is usually considerably higher than in bridge projects?

Why are existing BIM solutions for buildings apparently not suitable for efficient application in the bridge industry?

Two relevant factors can be nominated why the use of standard tools developed for buildings are seldom enough for bridge design requirements: the complexity of the geometry and the high dependency of the structural behavior from construction sequences and erection techniques.

The heart of any BIM process, the digital model of the structure, must be able to deal with complex geometric conditions, and additionally, it must be able to model the stage-wise construction process.

It means that we need an intelligent 4D model including a variety of functionality required throughout the design and construction process. The bi-directional data exchange between BIM model and structural analysis is required.

The digital model must suit all needs of the process, from the preliminary design phase via detailed design and construction to the operation phase throughout lifetime.

Different stakeholders are involved in these different phases; therefore, interfaces must be provided and the whole process must be shaped to avoid misunderstandings, errors and multiple entries of redundant data as far as possible.

Bridge structures are generally highly governed by the construction process requiring specific structural analyses and in-time outputs to be checked during the process.

ALLPLAN SOLUTION

Considering these premises, ALLPLAN has been working on a new technical solution especially tailored for bridge engineering.

Heart of it is the bridge modeler, based on a strictly parametric description of the bridge geometry. That means the model database contains design parameters and development rules rather than detailed geometric data in form of coordinates in space.

The actual detailed geometry is automatically retrieved from these parameters whenever needed, e.g. for visualization.

This data structure facilitates continuous raising of the level of detail throughout the design phases with minimal effort.

For stress computations, the structure must be mathematically modeled in a suitable way to allow a mechanical analysis in accordance with accepted calculation methods and design code prescriptions.

This requires the adaptation of the geometric BIM model to a suitable computation model in accordance with beam or finite element theory.

- With the new solution the mathematical calculation model is automatically derived from the physical model.

Design modifications throughout the planning process are always a crucial point, labor-intensive and error prone.

- With the new solution bridge modelers, structural engineers and designers can meet these challenges.

The geometric and analytical models are ideal for visual design and coordination: when the design is modified, all associated bridge elements - including the analytical model – are automatically adapted.

Although the solution automatically generates the analytical model from the physical model, the engineer retains full control by specifying structural parts and those ones which contribute as load only.

An additional analysis-relevant definition is the choice, whether a beam model or a grillage model should be generated.

Pre-stressing tendons with immediate or later bond, internal and external, longitudinal, transverse and vertical, as well as with non-standard geometry are easily accommodated and a facility for simulating stressing sequences allows optimizing the stressing force diagrams.

In concrete structures, the phase-wise construction not only results in built-in stresses due to the changing static system, but the time-dependent behavior of the material concrete plays a significant role.

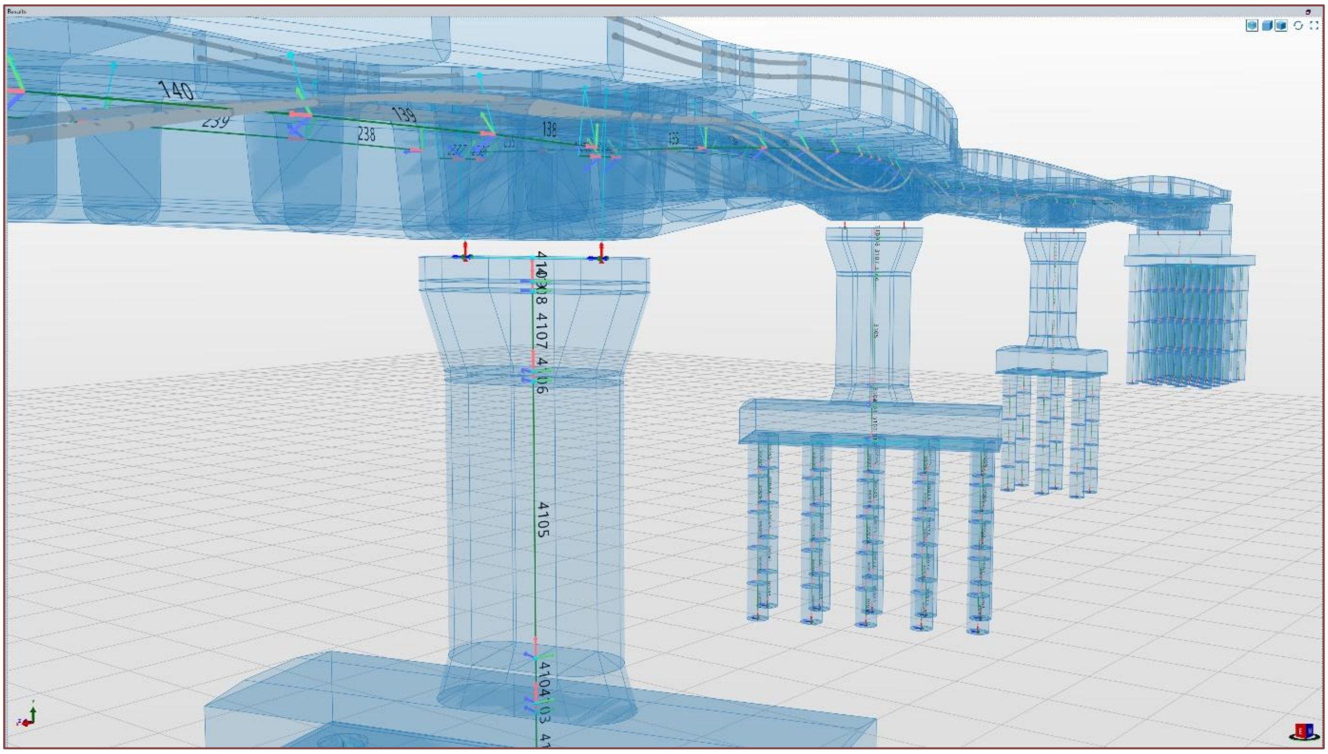

Figure 2: In Allplan Bridge, the analytical model is automatically derived from the geometric model. The engineer retains full control over which components contribute to the load-bearing behavior and which only represent loads. Copyright: ALLPLAN Infrastructure

This applies in particular to prestressed structures, where the phenomena creep, shrinkage and steel relaxation increase structural deformations and yield significant prestressing losses, which may be decisive for the structural behavior.

When calculating the detailed tendon geometry, the program determines the selected variable values automatically, using an intelligent algorithm minimizing the friction losses in the stressing process.

Once the user specifies the point in time when the tendon is stressed the product generates automatically the corresponding load cases and actions and applies the load on the structure.

<u>Assembling construction sequence calculation</u>

The bridge engineer analyses the defined construction schedule and sets up all necessary calculation definitions in an automated process, like load cases, element activations and calculation actions.

This includes input data for calculating nonlinear time effects, like creep, shrinkage and relaxation.

Complete transparency is granted, the user keeps full control of the generated items and result overview at any time of construction.

The weight and the position of superimposed dead loads (like sidewalks, road pavement, etc.) are automatically retrieved from the geometrical model.

The user needs to specify the point in time when the equipment is installed and the load is accordingly applied on the analytical system.

A structural analysis is performed for all automatically and manually generated calculation actions, defined in the construction schedule.

Furthermore, the nonlinear calculation of time dependent effects is performed, considering design code formulas.

The schematic definition of the load case superposition combines flexibility with clarity. It is possible to select several stress components in user-defined stress points and perform a stress leading superposition.

Moreover, the superposition allows for storing corresponding results for selected elements.

<u>New generation of bridge design software</u>

With Allplan Bridge Solution, a completely new platform has been created that is designed for simple operation and efficient workflows.

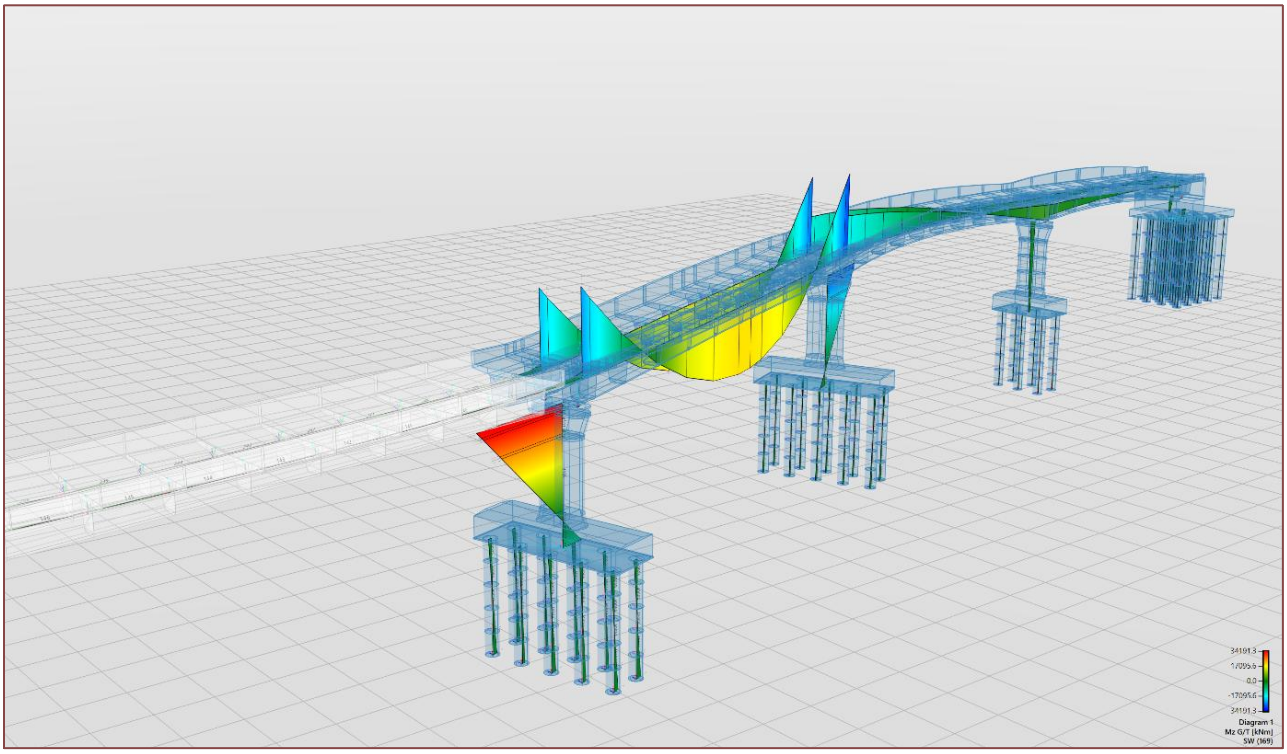

Figure 3: Allplan Bridge now also enables structural analysis. Additional loads are automatically taken into account. Information for calculating time-dependent effects is automatically determined from the construction progress. Copyright: ALLPLAN Infrastructure

By using one common digital model instead of two separate ones, interdisciplinary collaboration is improved.

The parametric model and the extensive automation of work steps reduces the time required for otherwise time-consuming and error-prone design changes.

The entire 4D model adjusts in the event of any change, such as to the alignment. So if the geometry of an axis changes, the entire bridge model is automatically adjusted.

This applies to the analytical model including construction sequence definition and the associated load cases and calculation actions.

Challenging bridges with double curvature alignments and varying cross-sections are reinforced conveniently and rapidly.

The reinforcement is defined in different cross-sections and the transitions between the cross-sections are described with paths.

Various rules can be defined, such as how the reinforcement joints are to be carried out. Using this information, the reinforcement is automatically generated.

The digital bridge model contains a multitude of information. Comprehensive reports with dimensions, areas, volumes, weights and quantities as well as rebar bending schedules are available at the touch of a button.

Elevations, longitudinal sections along any path and transverse sections are derived from the digital bridge model. Realistic visualized model, construction sequences and high-quality construction documentation are available for project members.

With the combination of the cloud-based BIM platform Allplan Bimplus, everyone involved has access to the latest design, anytime, anywhere and with any device. BIM coordination happens interactively on the digital bridge model.

Discrepancies are detected at an early stage and resolved jointly. This is an important contribution to ensuring that the construction project is completed on time and within budget.

Allplan Bridge represents a new generation of BIM Bridge solution, which should help the bridge industry in more efficient and connected bridge project execution.

The latest technology should ensure that engineers are not restricted in their freedom and creativity despite the high degree of automation.

HEAVY RAINS DEVASTATE WESTERN KENYA

Flooding and mudslides continue as the known death toll rises.

More than 1 million people are affected.

The death toll in Kenya continues to rise in the wake of recent torrential rains and catastrophic flooding.

Currently, 65 people have lost their lives, an estimated 1200 have been displaced, and more than 1 million people have been affected.

Mudslides have been a primary concern and have accounted for at least 29 of the known deaths.

According to Interior Cabinet Secretary Fred Matiangi, 17 people died in a mudslide in the village of Tamkal in the Pokot Central District, while 12 others lost their lives in mudslides in the villages of Parua and Tapach in Pokot South.

The flooding and mudslides come on the heels of an earlier severe drought in the region that left many people reeling.

Now, according to the Weather Channel, heavy rains are expected to continue for four to six more weeks.

Government officials sent military and police helicopters to help those affected by the floods, and are assessing the full extent of the damage in concert with humanitarian aid workers.

While rescue and recovery efforts remain the priority, there is great growing concern for the ongoing needs of the people in these areas.

According to a statement released by Kenyan President Uhuru Kenyatta's office, the rains, subsequent floods and mudslides have caused "massive destruction" to infrastructure like bridges and roads.

The statement continued, *"To those who were injured in the calamitous incident and are receiving treatment in different hospitals I pray for your quick recovery and restoration."*

Bridging the Gap Africa founder Harmon Parker who has led this effort to build numerous pedestrian bridges in this region over the past 20 years – many of which have been destroyed by the catastrophic floods and mudslides – responded to the disaster, saying in a statement:

"The magnitude of these floods has devastated the region. So many people are suffering, and our organization will continue to support affected families in any way we can. We are here, on the ground, and well-positioned to help rebuild and reconnect the communities to their schools, market places, medical clinics – and ultimately, to each other."

Parker, a recipient of a 2010 CNN Heroes award for his Kenyan bridge building efforts, reports that bridges are tremendously important and needed in this region so villagers in isolated communities can cross rivers and treacherous landscapes safely, quickly, and without danger. When there is a flood, they cannot get to schools, clinics or even the food market.

With the recent floods and relentless torrential rain, the country has seen mass displacement and villages buried under earth.

These sorts of rains are uncommon in Kenya for this time of year. Experts have said the changing weather patterns have had a huge impact, because close to 100 percent of Kenya's agriculture is rain-fed.

To learn more about Bridging the Gap Africa and how to help the people impacted by the flooding in Kenya, visit

bridgingthegapafrica.org.

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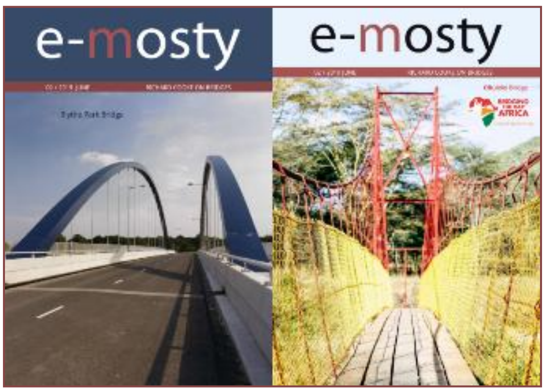
Read an article "A Community Approach to Enabling Sustainable Footbridges"

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

from Bridging the Gap Africa

in e-mosty June 2019

(Click On The Image To Open The Magazine)



Editorial Plan

We are working on some special issues of e-maritime and e-mosty magazines.

If you and your company have been involved in related projects and are interested in cooperation and preparation of an article for our magazines, please contact us. We welcome cooperation with you and your articles which we will be happy to publish.

e-mosty March 2020

D4R7 – Bridge over the Danube

Design. Foundations. Construction. MSS. Expansion Joints. Bearings

In cooperation with

- D4R7 Construction
- Dopravoprojekt
- PORR. PORR Grundbau
- Maurer
- Mageba
- BERD
- Construgomes

Drafts by 30 January 2020
Release 20 March 2020

e-mosty June 2020

N25 New Ross Bypas – Rose Fitzgerald Kennedy Bridge

Design. Construction. Formwork Travellers.

In cooperation with

- BAM PPP
- ARUP
- CFCSL
- Rúbrica

Drafts by 30 March 2020
Release 20 June 2020

*We are already **working on other e-mosty future editions**, and planning articles which include for example:*

- *A series of articles in cooperation with the The Universitat Politècnica de Catalunya*
- *Technical articles about lifting and transportation of bridges in cooperation with ALE*
- *An article about a floating crane "I lift New York"– Left Coast Lifter in cooperation with TZC/Fluor*
- *Articles about Croatian Bridges including the Pelješac Bridge*

And hopefully

- *A special edition dedicated to 1915 Çanakkale Bridge in Turkey which is planned for publication around the time of completion of the bridge*
- *An article about Design and Construction of the Brăila Suspension Bridge in Romania*

e-maritime March 2020

Shipyards, Ports and Maritime Industry in Turkey

Drafts by 30 January 2020
Release 30 March 2020

e-maritime

PLANS FOR JUNE AND NOVEMBER 2020 EDITIONS:

- Jazan Port (in cooperation with AECOM)
- Monaco Land Extension (in cooperation with BOUYGUES)
- Technical Articles in cooperation with Peel Ports

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

We would like to offer you partnership with e-mosty.

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

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.

The magazine is with Open Access with possibility to subscribe (free of charge).

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.

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

In January 2019 we established an official page on LinkedIn with constantly increasing number of its followers.

Number of subscribers is also increasing.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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 bridgingthegapafrica.org.

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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.

e-mosty

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5 Years of e-mosty magazine

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