www.bbrnetwork.com

Edition 17 | 2023

CONNECT

THE MAGAZINE OF THE GLOBAL BBR NETWORK OF EXPERTS

SIX SYNCHRONIZED BRIDGE SLIDES
Simultaneous launching in Poland

DRIVING QUALITY & INNOVATION
Special feature with BBR Saudi Arabia

HIGHEST POSSIBLE CORROSION PROTECTION
Roofing over major highway in Switzerland

FIT FOR THE FUTURE
New life for highway viaduct in France

WORLD-BEATING BBR STAY CABLES
First system fully tested to *fib* Bulletin 89

A Global Network of Experts

www.bbrnetwork.com

The BBR Network is recognized as the leading group of specialized engineering contractors in the field of post-tensioning, stay cable and related construction engineering. The innovation and technical excellence, brought together in 1944 by its three Swiss founders – Antonio Brandestini, Max Birkenmaier and Mirko Robin Roš – continues, almost 80 years later, in that same ethos and enterprising style. From its Technical Headquarters and Business Development Centre in Switzerland, the BBR Network reaches out around the globe and has at its disposal some of the most talented engineers and technicians, as well as the very latest internationally approved technology.

THE GLOBAL BBR NETWORK

Within the Global BBR Network, established traditions and strong local roots are combined with the latest thinking and leading edge technology. BBR grants each local BBR Network Member access to the latest technical knowledge and resources – and facilitates the exchange of information on a broad scale and within international partnering alliances. Such global alliances and co-operations create local competitive advantages in dealing with, for example, efficient tendering, availability of specialists and specialized equipment or transfer of technical know-how.

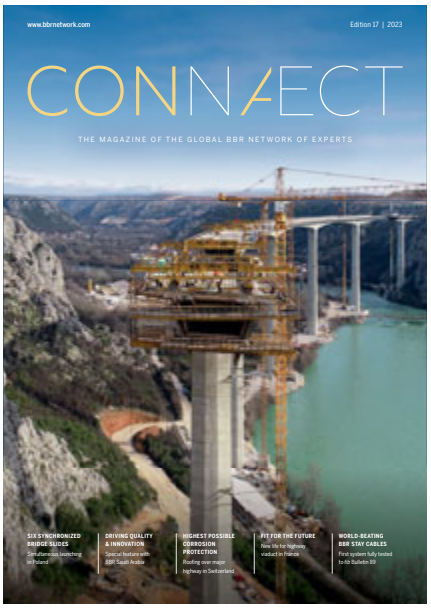
ACTIVITIES OF THE NETWORK

All BBR Network Members are well-respected within their local business communities and have built strong connections in their respective regions. They are all structured differently to suit the local market and offer a variety of construction services, in addition to the traditional core business of post-tensioning.

BBR TECHNOLOGIES & BRANDS

BBR technologies have been applied to a vast array of different structures – such as bridges, buildings, cryogenic LNG tanks, dams, marine structures, nuclear power stations, retaining walls, tanks, silos, towers, tunnels, wastewater treatment plants, water reservoirs and wind farms. The BBR™ brands and trademarks – CONA®, BBRV®, HiAm®, HiEx, DINA®, SWIF®, BBR E-Trace and CONNÆCT® – are recognized worldwide. The BBR Network has a track record of excellence and innovative approaches – with thousands of structures built using BBR technologies. While BBR's history goes back nearly 80 years, the BBR Network is focused on constructing the future – with professionalism, innovation and the very latest technology.

BBR VT International Ltd is the Technical Headquarters and Business Development Centre of the BBR Network located in Switzerland. The shareholders of BBR VT International Ltd are BBR Holding Ltd (Switzerland), a subsidiary of the Tectus Group (Switzerland) and KB Spennteknikk AS (Norway), a subsidiary of the KB Group (Norway).



World class technologies & performance

The 2023 edition of CONNÆCT, the annual magazine of the BBR Network comes to you with our compliments. Contained within the following pages is a showcase of the blend of technologies and services that our highly-skilled BBR specialists around the world deliver for their customers.

Take a look at the Bridges section and you will find that there is a bridge for every purpose – all created with many different BBR technologies and techniques. The BBR Network has been creating new records with innovative approaches to bridge construction for road, rail, pedestrians and cyclists.

Meanwhile, in the Buildings section you will gain a fascinating insight into the Saudi Arabian market, along with features on buildings for manufacturing and distribution, for office workers and for holiday-makers! It's a world tour of purpose-designed spaces – all realized with BBR technologies.

On the Special Applications front, there is also a wealth of different projects and techniques for you to explore. The range runs from installation of specialist BBR VT CONA CMX electrically isolated PT tendons, to massive world record dam anchoring. Along the way, you can marvel at an extraordinary heavy lifting project in Thailand, as well as learning about the testing of dam anchors and some recent construction projects with prestressed timber in New Zealand.

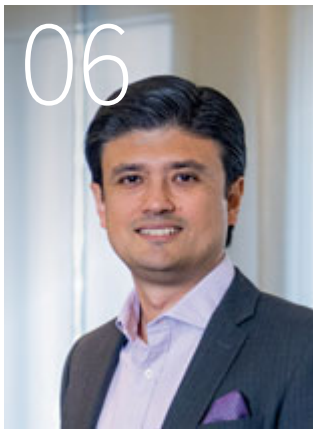
Maintenance, re-use and recycling of our infrastructure has never been more important. Here, in the MRR section, we present major infrastructure strengthening and several projects to repurpose, revitalize or restore buildings. The skills and capabilities of the BBR Network in this field are considerable.

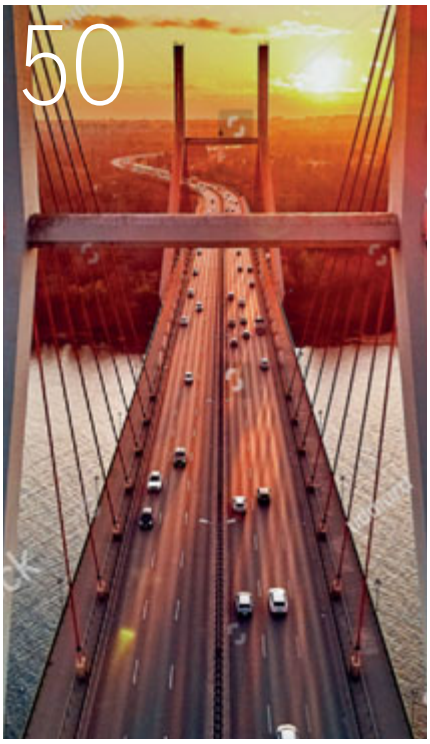
The demands of today's customers and environment pushes our technology ever further and you can appreciate this through the features in the Technology section. After announcing that CONA CMG had become the world's first ETA approved strand ground anchor in the last edition, you can now learn about yet another 'world first'. This time it's for the BBR HiAm CONA stay cable system which is the only one to have been fully tested to *fib* Bulletin 89 criteria. The lead feature in this section reviews the R&D journey which has led to this amazing achievement. Further features cover the various R&D achievements of the past decade and also the how BBR's early adoption of a digital approach to QA has extended to deliver the most advanced and efficient supply chain operation in the industry.

We hope you enjoy reading this edition and look forward the opportunity of discussing your own projects with you in coming months.

Dr. Antonio Caballero
Co-Chairman, BBR VT International Ltd

José Manuel Illescas
Vice Chairman, BBR VT International Ltd

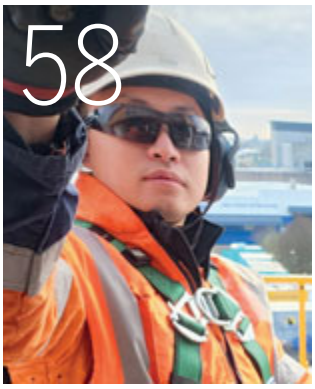


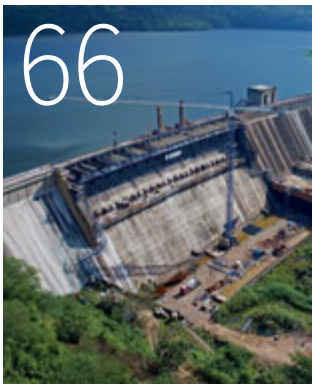


Contents

TALKING BBR

PORTFOLIO





TECHNOLOGY

BBR DIRECTORY

Editorial, sources and references

EDITORIAL OFFICE
BBR VT International Ltd
Technical Headquarters and Business Development Centre, Switzerland
www.bbrnetwork.com
info@bbrnetwork.com

EDITOR
Jane Sandy
CONTRIBUTING EDITOR
Marco Zucconi
DESIGNER
Jenny Chillingworth
PUBLISHER
BBR VT International Ltd

p-ISSN 1664-6606
e-ISSN 1664-6614

CONTRIBUTORS
Nghaimish AlHarbi, Mohamad AlShal, Lujain S. Al-Umran, Mohammed Ashour, Jérémie Baumgartner, Claas Belling, Derek Bilby, Zelimir Bodiroga, Sarah Brown, Javier Rivera Casado, Daniel Cuerdo, Antoine Dupré, Oukba El-Assaad, Abdulrahman El-Fateh, Dr. Haifeng Fan, John Gin, Kadir Serden Hekimoğlu, Peter Higgins, Michael Huwiler, Tomasz Jendernal, Sean Kelly, Marko Krešić, Ivan Kušt, Murat Kutay, Michael Lawson, Dickson Liew, Juan Linero, Juan Maier, Dr. Behzad Manshadi, Maciej Michalczyk, Vutshila Mkhatshwa, Valentina Mihajlovic, Marcin Ornat, Sam Pearce, Prof. Predrag Presečki, Siwadon Pongwat, Bojan Radosavljevic, Suzana Sapina-Dubravac, Mark Seisun, Mark Sinclair, Jacek Sowa, Marek Strzoda, John Taraldsen, Jackie Voon, Dr. Xiaomeng Wang, Paul Wymer.

SOURCES AND REFERENCES
Front cover image: Free cantilever construction underway at the Počitelj Bridge in Bosnia and Herzegovina. This continuous prestressed reinforced concrete motorway bridge is 745m long and 100m high – and features BBR post-tensioning technology supplied by local BBR Network Member, BBR Adria. The full story will appear in CONNÆCT 2024.

Portfolio section
Night at the ballet: https://projets.ouvrages-olympiques.fr. www.linkedin.com.
Green light for rail schemes: www.mobility.siemens.com. www.infrapppworld.com. www.alstom.com. www.enr.com.
Monostrand for motoring: https://campus.rimac-group.com.
BBR GT solution for luxury resort: http://ammaresort.com. https://www.businesstraveller.com.
Tanks for everything: www.watercorporation.com.au.
It's a wrap: https://atelierlavieksa.com.

This paper is manufactured with 15% recycled fiber, FSC certified.
All pulps used are Elemental Chlorine Free (EFC) and the manufacturing mill is accredited with the ISO14001 standard for environmental management.
Vegetable based inks have been used and 85% of all waste associated with this product has been recycled.

Business Review Reflections & outlook from BBR VT International's CEO

Climate for championing change

Change has been a frequently used word over recent years. We hear about embracing change to harness new technologies and also about the urgent need to halt climate change. BBR VT International CEO Juan Maier examines how tackling these two issues involving change can deliver significant returns for all stakeholders.

The resilience of the human spirit is an incredible thing. Time-and-time again we've seen how people come together – even when faced with great adversity – to make something happen. The built environment contributes 40% of annual global CO_2 emissions, the majority through embodied carbon. This needs to change. Our common resolution today must be to save the planet, quite literally. Yes, it's a dramatic proposition, but is also a challenge that we face together. We must share and apply our knowledge, skills and resources to achieve this common and singularly vital goal.

The pressure to reduce carbon emissions is coming from all levels including governments, corporates and society across different generations, income levels and social classes. This means that we must strive to take a holistic view of how we can each contribute to the well-being of our planet and, therefore ourselves and future generations. Global dialogues are underway at all levels and these are mirrored within the BBR Network as we are here to help companies, governments and communities to lower their CO_2 footprints. Our technologies and services promote a carbon efficient approach to construction and also to repurposing or prolonging the life of existing structures.

Creating new structures

We must work to spread the word further about the advantages of using, for example, post-tensioned methods of construction. Through the use of post-tensioning, it's entirely possible to reduce embodied CO_2 in buildings by between 30-50% – depending upon the structural configuration and loads. Thereby, materials usage is reduced, construction programs are sped up, spans and clearances between columns and walls are increased – all of these advantages come with lower construction costs too. Significantly, post-tensioning also increases the strength and durability of concrete structures, allowing them to withstand greater loads and resist cracking and deformation which in turn leads to longer-life structures.

The BBR post-tensioning product range is tailored to the needs of almost any structure, ensuring optimal CO_2 efficiency gains while enhancing the structure so that it is truly built to last and thereby significantly increasing its value to all stakeholders.

So that was new-build construction, what about our existing structures?

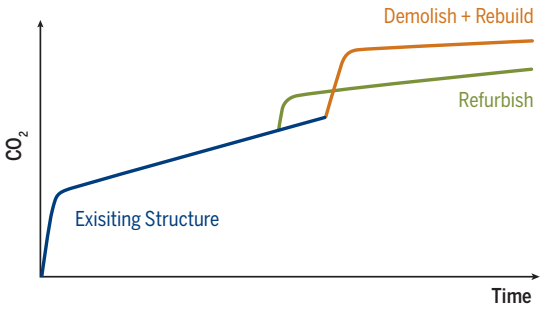
Conserving assets

Asset conservation – including refurbishment and repurposing or adaptive reuse – is a major way that we can improve our approach to the built world. What's more, by tackling this issue substantial value can potentially be unlocked for the asset owner, as well as for the environment and the community.

By repurposing existing structures, we can avoid the embodied carbon emissions associated with new construction, and instead focus on making existing structures more energy-efficient. In fact, some new-build structures today are even being designed in ways which allow their later repurposing.

Adaptive reuse can also help preserve the character and continuity of a community, while providing new opportunities for economic development. For example, repurposing an old factory into a mixed-use development can bring jobs, housing, and other amenities to a previously industrial area.

In addition to reducing embodied carbon, refurbishment or adaptive reuse can also have a positive impact on the environment in other ways. For example, it can help preserve



Carbon emissions generated by the demolition and rebuilding of an existing structure, as compared with its refurbishment.

green spaces by avoiding the need to clear land for new construction. It can also help reduce water and air pollution associated with new construction.

As with new-build construction, the depth and range of BBR's product portfolio across post-tensioning, stay cable, geotechnical and MRR* technologies enable asset owners to conserve, extend and repurpose their stock of existing structures unlocking further value for all stakeholders.

Harnessing new technologies

Almost 80 years ago, post-tensioning was a new concept. The BBR founders were not afraid of this, instead they embraced it to help solve a problem – at that time, it was material shortages. Since those early days, PT has become an accepted construction method – and BBR has never stopped developing the technology and adding new ones, so that now we have choices for every type of structure. We want to encourage the built-to-last approach, not only for new build construction but also for extending and repurposing existing structures. On pages 86-91 you will see how BBR has been innovating within its product portfolio over the last 10 years.

For many years now, the construction industry has been using digital technologies to support efficient design, but since 2009, the BBR Network has been using a digital web-based platform to ensure the smooth operation and efficiency of our whole supply chain model. There's more about this unique, purpose designed platform on pages 92-93.

My point here is that BBR has, again, gone the extra mile and is maximizing value for all stakeholders by engaging with the latest and most advanced technologies to deliver outstanding services to our customers.

Making a positive impact

Ultimately, for effective change to happen, we must all be both custodians and champions for our built world, using precious materials wisely and delivering world class technical solutions and, crucially, supporting others to do the same. By doing so, we can achieve meaningful progress and make a positive impact on the world around us.

* MRR = maintenance, repair & retrofitting

News-in-brief

Overview of events & achievements from around the BBR Network

The past 12 months have been all about celebrating – for technology achievements, for award-winning projects, for the environment and sometimes just for the joy of being among the world's finest specialist construction engineers. Here's a few highlights of an action-packed year around the BBR Network!

EARTH AWARD FOR BBR PROJECT

Congratulations to the whole team for their excellent work on the New England Highway Upgrade at Bolivia Hill, Australia – see CONNÆCT 2021 for full details. The JV of Georgiou Group and SRG Global scooped the winning prize in the CCF NSW's Earth Awards Category 6 – for projects in the A$75 million to A$150 million range. The Earth Awards are presented by the Civil Contractors Federation of New South Wales and recognize the excellence achieved on projects of various sizes.

REWARDING CAREFUL DRIVING

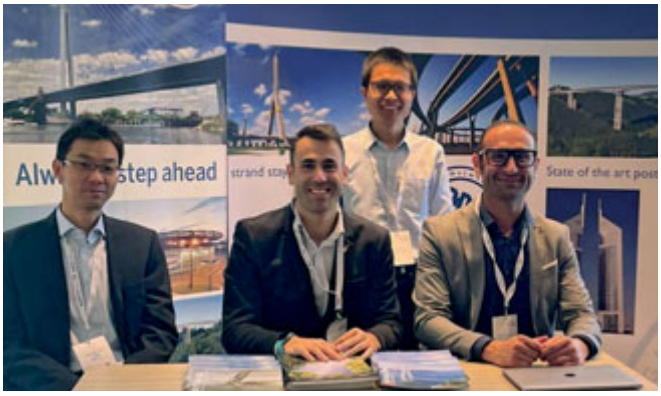
Safety and ecology are always at the top of the BBR Network's agenda and BBR Polska have recently applied this on a personal level. They have rewarded their firm's best drivers of company vehicles with a certificate of appreciation and small gift tokens. This is a great reminder to all of us that when driving around, whether for business or personal reasons, we should do so in a safe, economical way and with respect for the natural environment. Pictured here left to right are: Anna Grzegorek and Robert Milewski receiving their awards from Tomasz Jendernal. Congratulations to the winners and thank you BBR Polska for this timely reminder.

WAVE TO THE FUTURE

BBR Contech hosted two civil engineering interns for their work experience last summer, as part of their degree course. Alex McCarthy is seen here under supervision of Hale Tatu, a lead sprayer-nozzleman working with the wharf repair team, in one of the boats from which they install scaffolding brackets onto the underside of wharfs and tow working platforms into place. As well as doing work on site alongside the site team, they were involved in site planning activities and joined meetings with our client and subcontractors, giving them all round exposure to what construction is all about. We wish both Alex and fellow student Ralika Chhay all the best and hope to see them again after they have completed their degrees.

SHOWTIME FOR BBR!

After such a long period of travel restrictions, the BBR HQ team was delighted to be back on the conference and exhibition circuit during 2022 – and had some important messages to convey too. During their extended roadshow which ran from April to September, the team visited Vienna, Prague, Oslo, Barcelona and Helsinki to spread the word about BBR technologies and their advantages. Pictured here (left to right) at the BBR booth during the *fib* Congress in Oslo are: Dr. Xiaomeng Wang, Daniel Cuerdo, Dr. Haifeng Fan and Marco Zucconi.



BBR TRAINING & WORKSHOP

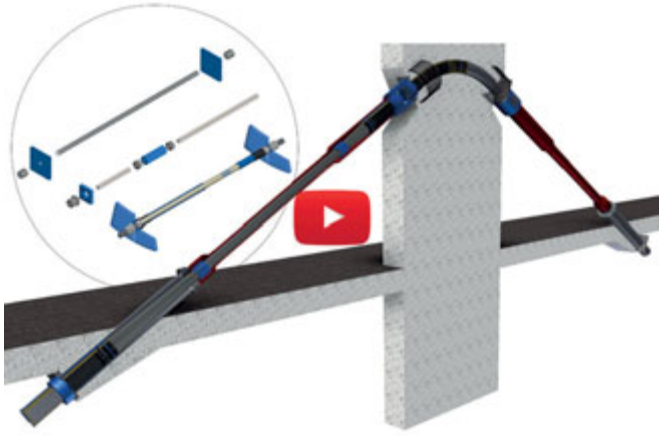
Project Managers from all over Europe converged on the French city of Marseille for an exciting three days of training, practical demonstrations and an awesome site visit.
As well as learning about latest developments on BBR post-tensioning, stay cable and geotechnical technologies, delegates had many opportunities to network and share their own experiences. The session culminated with a site visit to the nearby Bonpas Viaduct strengthening and repair (MRR) project. Many thanks to all who attended – and especially to local BBR Network Member ÆVIA for hosting us for such an interesting site visit.

TRIO OF TECHNICAL PAPERS

In spring 2022, members of the BBR HQ R&D team delivered presentations on important technical papers at three industry conferences. First up was the IABSE Symposium in Prague where Dr. Xiaomeng Wang gave a lecture on the durability of strand ground anchors, through which the various origins of corrosion of strand anchors during installation and service life were thoroughly analyzed, and the new standardized testing methods for assessing the durability performance of strand anchor were explained.
Next came the *fib* Congress in Oslo where two papers were presented. Dr. Xiaomeng Wang presented on BBR's innovative test method for testing grout crack widths – under service load – in strand ground anchors. Then the audience learned about the importance of CE marking of strand ground anchors based on the new regulation from Dr. Haifeng Fan.
Both of these topics are game-changers as they will drive greater durability, quality and sustainability into the geotechnical sector.
Finally, the focus moved to Barcelona and the IABSE Conference where Dr. Fan gave a presentation about 'Solutions for eliminating fretting fatigue due to micro-movement in friction saddles'. The presentation took place within a specialist Technical Session about design of bridge components considering the impact of micro-movements of flexible structures.

NEW BBR VIDEOS

Three new videos were launched in the past year. First came the 2022 BBR Network Highlights movie showcasing many projects from all around the globe and providing an overview of the massive capability and achievement of the BBR Network. Next came two more BBR Technical Series videos. One was about BBR threaded bars and it highlights the unique properties which set them apart from other systems. BBR C Bar, BBR WT Bar and BBR H Bar may be three different threaded bar ranges, but between them they cover most civil engineering and construction applications – and even include a hold down bolt solution for wind towers and other installations with cyclic loads. Last but not least was the video about the whole BBR HiAm CONA stay cable range – currently the ONLY stay cable system on the international market which has been fully tested to the new *fib* Bulletin 89 recommendations. Alongside the HiAm CONA system, there is a whole selection of great accessories too. You can see all three videos on the BBR Network YouTube channel.



Conference Notes BBR Annual Global Conference, Vienna, Austria 2022

Together again!

After only being able to meet virtually during the recent pandemic, in May 2022 delegates from all around the BBR Network gathered together again – in the beautiful Austrian capital city of Vienna – to catch up in person. The three day event offered opportunities to explore business themes, as well as to share knowledge during informal networking sessions and social events.

The Conference was a blend of business and social functions which offered maximum opportunity for the exchange of information between delegates. As well as the formal meeting sessions, several cultural experiences – along with a BBR Gala Dinner complete with string quartet – were arranged to provide a backdrop for international networking.

After a welcome from BBR CEO Juan Maier, during which he introduced delegates from BBR Saudi Arabia and from Becomar, the BBR Network Member from Morocco, the formal part of the conference began.

Updates from BBR Headquarters covered important issues, such as the fact that BBR is the first to have an ETA approved strand ground anchor technology and the first to have the a full stay cable range tested according to *fib* Bulletin 89 – and continues to work at full speed for the future to provide more innovative products to give still further competitive advantages to the BBR Network and its customers.

There was a particularly lively workshop session on the subject of asset conservation led by Dr. Behzad Manshadi and Daniel Cuerdo.

Along with solutions based on existing BBR technology there were wide-ranging discussions about new solutions, the fundamental importance of structural inspection and review of the customer journey at various stages of the process.

Next up, was Catarina Bjelkengren of Strategy&, PwC's global strategy consulting business, who delivered a thought-provoking presentation about supply chain logistics in the light of the recent pandemic, covering the key aspects of resilience, digitization and sustainability.

Making memories – delegates assemble on the Royal Stairs at Vienna's Imperial Hotel for a team photograph.

BBR GALA DINNER
The culmination of the whole event was the very grand BBR Gala Dinner which was held at the city's Imperial Hotel. Delegates were transported in style to the venue, in horse-drawn carriages. It was the perfect location to celebrate the many awards during the past 12 months – and indeed the previous two years – and, of course, enjoy being together again.

HELPING THOSE IN NEED
The tradition of supporting charities local to the conference venue saw the Flüchtlingsprojekt Ute Bock receive a donation from the BBR Network this year. Founded in 2002, the charity is an Austrian non-profit organization supporting refugees – by providing shelter, counseling, education and immediate aid – regardless of their place of origin. Many thanks, particularly to the BBR Network supply chain partners, for their generous support.
Left to right: Juan Maier, BBR VT International CEO with Brigitte Kainradl-Schmoll and Gerd Trimmal of Flüchtlingsprojekt Ute Bock.

RECOGNIZING CONTRIBUTION
This year, Claude Néant (left) of French BBR Network Member ÆVIA was presented with a Special Lifetime Achievement award by BBR VT International Co-Chairman, Antonio Caballero (right). The award was made in recognition of Claude's long-term dedication to the delivery of the finest technological solutions and also acknowledges the important role he plays in mentoring others.

LOOKING TO THE FUTURE
In his speech at the Gala Dinner, Bruno Valsangiacomo-Brandestini, Co-Chairman of BBR VT International, welcomed delegates and congratulated them – and their teams around the world – on their recent achievements. As always, his was very much a forward-looking address and before closing he hinted at exciting news which would be announced over coming months.

THE NEXT GENERATION
The international family that is the BBR Network sometimes has the opportunity to welcome younger delegates to the conference venue too. Jackie Voon from BBR Malaysia, already the second generation of the Voon family to embrace civil engineering using BBR technologies, is pictured here (right) with his wife and their son. Maybe in a few years' time, we can expect to see a THIRD Voon generation to take up the reigns. Also, we were delighted to meet Nikša and Lana, the two eldest children of Zelimir Bodiroga (left) from BBR Adria. Perhaps they too will be inspired to take up a career in specialist civil engineering.

BBR Awards 2022 Outstanding achievements by BBR Network Members

Awards for excellence

Members of the BBR Network strive for excellence in every new project they undertake and the annual BBR Awards seek to recognize this dedication. Of particular interest to the international judging panel are innovation, engineering and customer service – three key attributes which drive the entire BBR Network in their daily work.

BBR PROJECT OF THE YEAR 2022

The competition this year for BBR Project of the Year was particularly hotly contested with the Pulau Poh Bridge in Malaysia just edging ahead of its rivals. The judges favored this project because BBR Malaysia proposed an innovative technical solution based on an alternative design concept for the pylon of this stay cable bridge which promoted greater on-site productivity, while the incorporation of unique cultural artworks fulfilled their customer's vision. Also shortlisted were Bridge construction, S7 Expressway, Poland; Building G2, Chappelle Internationale, Paris, France; Block E7, National University of Singapore; Merredin Water Storage Tank, Western Australia and two Countdown Distribution Centers, New Zealand. For an overview of all the finalists, please have a look at the short video on the BBR Network YouTube Channel – or you can also find more detailed information about each project in CONNÆCT 2022.

BBR CONNÆCT BEST ARTICLE AWARD

BBR CONNÆCT BEST PHOTOGRAPHY AWARD

2022 BBR Award Winners

BBR NETWORK PROJECT OF THE YEAR AWARD

Pulau Poh Bridge, Malaysia – an innovative technical solution for the bridge pylon drove enhanced on-site productivity, while incorporation of unique cultural artworks fulfilled the vision of BBR Malaysia's customer.

BBR CONNÆCT BEST ARTICLE AWARD

Winner: BBR Polska (Poland)
Title: Poland's longest expressway (Bridge construction, S7 Expressway, Poland)

Runner-up: SRG Global (Australia)
Title: Making new history in Merredin (Merredin Water Storage Tank, Western Australia)

Highly Commended: BBR Construction Systems (Malaysia)
Title: Harnessing benefits of top-notch expertise (KVLRT3, Klang Valley, Malaysia)

BBR CONNÆCT BEST PHOTOGRAPHY AWARD

Winner: ÆVIA Câbles et Manutention (France)
Title: Uniquely placed reinforcement (Structural strengthening with external PT for Building G2, Chapelle Internationale, Paris, France)

Runner-up: BBR Construction Systems (Malaysia)
Title: Tradition meets modernity (Pulau Poh Bridge, Terengganu, Malaysia)

Highly Commended: BBR Polska (Poland)
Title: Creating landmarks in Katowice (KTWII Skyscraper, Katowice, Poland)

More about
BBR Project of the Year

Sharing a vision for six decades

This year, BBR Contech – the BBR Network Member for New Zealand – celebrates its 60th Anniversary. In this special feature, we look at the people whose breadth of vision has shaped the business and those who continue to steer and strengthen it through their commitment to innovation and technical excellence. Paul Wymer who has recently celebrated 30 years with the company, takes us on a journey to meet some of the long-serving team members who reflect on the recent employee awards and a few of their favorite projects.

He aha te mea nui o tenei ao?
He tāngata,
he tāngata,
he tāngata.

Māori proverb

What is the most important thing in this world?
It is people,
it is people,
it is people.

OUTSTANDING SERVICE FOR 40 YEARS

Mike Lawson (left) was the inaugural recipient of the **Rob Irwin Excellence Award** presented by Derek Bilby (right). This award was created to recognize those team members who are our most experienced and who have shown dedication and commitment to the company – often through some very demanding circumstances. They are highly respected and trusted by our key customers. Their contributions have grown and developed the business and they are pillars of our team who provide strong support to the organization. Mike's 40 years of outstanding service exemplify the highest standards of delivery excellence.

EXTRAORDINARY EFFORTS

Havea Oneone (above) received a **Bill Morton Standout Performer Award** for his outstanding performance as a post-tensioning supervisor. During Covid-19 disruptions, Havea pulled together an ever-changing team to keep the Foodstuffs and other major slab-on-grade projects in line with client programs. At times, this involved some long days and extraordinary efforts to deliver for some of our most important customers. Havea's performance on these two projects is typical of the large number of post-tensioned projects he has delivered during 23 years' service with BBR Contech.

Today, we are in a position of having more long-serving staff – with over 10 years' employment – than at any other time in our history. As with many success stories, the BBR Contech history can be traced back to a series of events and, most significantly, to a vision which was shared between key players.

Founding fathers

Our story goes back to the 1950s when Roxburgh Dam in Otago, South Island was constructed by an international joint venture including Swiss-based Conrad Zschokke AG. Zschokke subsequently founded a firm in New Zealand. Meanwhile, young Kiwi engineering graduate Rob Irwin traveled to Europe and took a job with Zschokke's firm. In the early 1960s, the NZ market was seeking post-tensioning services. So, Zschokke introduced Irwin to Antonio Brandestini who had worked for the firm, but had since founded the BBR business along with two colleagues. From here, the vision of a better built world in the future and the determination to drive it forward together materialized and this mission continues today.

Cultivating delivery excellence

With post-tensioning established on infrastructure projects elsewhere in New Zealand, Mike Lawson was one of the founding employees in the Auckland branch. In 1983, he joined a team being developed by Rob Irwin and Rob Robinson to provide a range of post-tensioning services and is now our longest serving staff member. The work was varied and included motorway bridges, rail bridges, water reservoirs and related work in the development of New Zealand's heavy industry infrastructure.

For Mike, it all started with post-tensioning and those early days saw involvement with the BBRV wire system and then a transition to the BBR VT CONA CMX strand system used today. His operational, technical and management skills were developed across a wide variety of projects – involving post-tensioning, ground anchoring, grouting, heavy lifting and MRR. He was involved early in concrete repair and structural upgrading projects requiring innovations – like impressed current cathodic protection and FRP strengthening – contributing to some of the largest projects ever undertaken using these techniques. He then went on to apply all this knowledge into attaining international quality and safety certifications for the business.

More recently, having returned to his post-tensioning roots, Mike has held an operational and technical management role related to PT slabs on grade and multi-storey post-tensioning. Key achievements include The Pacifica Building and Foodstuffs Distribution Centre. Mike notes that the success of these projects is the result of a full team effort and the leadership and experience of some of our most experienced supervisors and skilled operatives.

Teamwork principles

Bojan Radosavljevic has worked in the BBR Contech Wellington branch for over 25 years. Structural upgrading and seismic resilience feature strongly here and his team has delivered a wide range of projects to repair and strengthen bridges, buildings, roads, wharves, tunnels, reservoirs and wastewater infrastructure. However, Bojan regards the North South Junction rail tunnel upgrade project in 2010 as one of the most memorable. A number of existing brick-lined rail tunnels were to be lowered and strengthened, during a non-extendable four month track closure. BBR Contech was responsible for work stretching across five separate tunnels and involving installation of some 1,750 rock bolts and 500m^3 of grout. Technical and operational challenges were encountered which saw the project operating 24/7.

Bojan credits this project with embedding the principles of teamwork, collaboration, planning, resilience, dedication and commitment – he has never been associated with a project that was so difficult on every level. The whole professional team worked tirelessly to overcome the difficulties and deliver a successful result on time. He has a special photo on his wall that was taken in the tunnel just prior to completion – to recognize the achievement and record the successful delivery of this work. He looks to this project – and the photo – for his motivation and inspiration whenever his BBR Contech team face high demands and challenging circumstances. ›

CAPTURING THE MOMENT

In 2010, Bojan Radosavljevic (right) and his senior project supervisor Richard Awa (left) posed for the camera to record the completion of the North South Junction tunnel project. Now, Richard Awa boasts 22 years' service and has recently received a **Bill Morton Standout Performer Award** in recognition of delivering excellent outcomes for clients and the BBR Contech business. While the award recognizes his achievements on complex projects during the pandemic, Bojan believes that skills – such as teamwork, trust and resilience – developed during the rail tunnel project contribute to his continued successful delivery of projects today. Another significant achievement and another photo to capture the moment.

EXCELLENT OUTCOMES

Peter Higgins (right) recognizes the contributions of key team members at the Christchurch branch such as Senior Foreman, Shayne Riwaka (left). Like Peter, Shayne has also been with the business for 20 years and he recently received a **Rob Robinson Outstanding Contribution Award**. Shayne's contribution and commitment has spanned some challenging times and varied projects including the Transpower Transmission Tower Foundation Upgrades, multiple post-tensioned slabs for Fonterra and Synlait, and the remedial works following the Christchurch earthquakes.

All round high performance

Peter Higgins has the led our Christchurch branch team for the past 20 years. He has overseen some significant projects and achievements during that time, as well as navigating the team through the Christchurch earthquakes of 2011 and 2012 – and the vast recovery and rebuild program that followed. While earthquake repairs and seismic upgrading could easily define his tenure, it is the considerable development of post-tensioned slabs in his region that Peter reflects on with particular pride. The promotion of PT slabs here started when he first joined BBR Contech and, today, the region's portfolio features over one million square meters of PT slabs across 160 projects. The dairy sector in particular has embraced the benefits of PT slabs for premium quality floors with high load resistance, minimal joints and low maintenance. Applications include large storage warehouses, coolstores and heavy-duty load out aprons.

The BBR Contech team is recognized as the leading regional specialist and strong relationships have been forged with property developers, main contractors, and dairy companies alike. Peter is also confident of the high performance of the PT slabs – there were approximately 40 slabs in service when the Christchurch earthquakes hit and none of these suffered any damage. It is rare that structures are exposed to such extreme loading and thus very satisfying to know that our PT slabs performed to an exceedingly high level.

BBR Contech Success Stories

Transpower Transmission Tower Foundation Upgrade, Upper South Island – in this multiple award-winning project, the BBR Contech team provided upgrading and strengthening works to 160 towers, on a worksite which stretched across 300km!

Fonterra, Darfield – this is probably the largest development to use post-tensioned slabs on one site. To date, a total of 80,900m^2 of PT slabs have been constructed for drystore warehousing, packing stores, coolstore and heavy-duty external pavements.

Mark Kurtovich at Princes Wharf, Downtown Auckland – in the marine environment associated with many BBR Contech projects throughout his 33 years of service. In the background is Sky Tower, a BBR Contech project from the 1990s.

Sustainable & innovative solutions

Mark Kurtovich was hired by BBR Contech founding employee Rob Robinson in 1990 as a concrete repair project manager and is now the company's Business Development Manager. He has always been passionate about working closely with customers to develop solutions for restoring aging concrete structures. With over 60% of BBR Contech's business related to repair and strengthening of existing structures, Mark is well aware of the sustainability benefits of these solutions and our own quest for zero carbon. He is excited about the many innovations introduced to the market since his early days and is constantly looking for new products and techniques.

One of Mark's specialist areas of expertise is wharf repair and he has been associated with more than 20 wharf repair jobs in the Auckland area. His current project interest is Princes Wharf in Downtown Auckland – the largest under wharf repair tackled in the region to date and builds on a long career of similar jobs. Mark and the BBR Contech team worked on the wharf previously providing top-side concrete repair and seismic upgrading by FRP strengthening and ground anchors. Coincidently, it was also the venue for the BBR Annual Global Conference in 2013.

The work at Princes Wharf brings together all of Mark's past expertise and experience including specialist underwharf access, hydro-demolition, in-house designed marine repair concrete and working within a busy operational environment.

LEADERSHIP PORTFOLIO

Working alongside Mark Kurtovich in most wharf repair projects has been BBR Contech's Auckland Foreman, Ian Campbell. Ian was awarded the **Rob Robinson Outstanding Contribution Award** in recognition of more than 35 years of leading teams in delivering a wide portfolio of complex projects throughout NZ. He also made significant contributions to key projects in the Pacific Islands where his expertise was vital in delivering successful outcomes in remote locations. Ian's leadership and outstanding contribution has been fundamental to the success of many of the company's projects during the time of his service.

INTERNATIONAL ACCLAIM

It was a great honor back in 2018 to accept – from Antonio Caballero (left), then CEO of BBR VT International – the BBR Network Project of the Year Award on behalf of BBR Contech for our work on the award-winning PT floor slab for the James Pascoe Distribution Center in Auckland. This prestigious international accolade was only made possible through the dedication and commitment to excellence of our people. It represents so much more than just one project, it reflects our whole team's passion for delivering the finest technical solutions for our customers.

Foodstuffs Distribution Centre, Auckland – where BBR Contech installed the latest CONA CMF flat post-tensioning technology to create a 74,000m² floor slab – the largest ever to be constructed in a single project in New Zealand.

James Pascoe Group Distribution Centre, East Tamaki – this 25,000m² award-winning VNA (Very Narrow Aisle) super-flat PT floor was constructed by Conslab, with specialist PT expertise from BBR Contech who helped to deliver the best floor flatness level in the world.

The Pacifica Building, Auckland – this stunning 57-floor mixed use tower is a new landmark on the Auckland skyline and was realized using BBR post-tensioning for the elevated floors and lateral load resisting system.


LIEBHERR
WOLFFKE

S3 Expressway, Kamienna Góra, Poland Incremental launching

Six synchronized bridge slides

In the past 12 months, BBR Network Member BBR Polska has performed an almost theatrical feat of immense proportions, requiring not only great technical abilities, but also, a seamless logistical approach. Their highly skilled team has incrementally launched six bridge structures – simultaneously. Marcin Ornat and Marek Strzoda now present an account of how this challenging project was delivered – and reflect on whether the team has set a new construction industry world record!

As mentioned in the last edition of CONNÆCT, after the completion of our project for the Szczepanowice section of the S7 highway, the BBR Polska implementation team immediately began another challenge – this time, for the Kamienna Góra-Lubawka section of the S3 Expressway. This new road will be part of the trans-European E65 route, ultimately linking Sweden and Greece. Our scope of works here has included six flyover structures executed with incremental launching technology – and performed simultaneously. We were also responsible for constructing the prestressed elements, as well as the technical execution of the structure.

Location & scope

The scene for our project was the mountainous section of the S3 Expressway. The main contract was for the design and construction of the S3 Legnica (A4) – Lubawka road, including the Kamienna Góra junction, to the border with Czechia.

This new road section is around 15.3km long and in the form of twin dual-carriageways. As part of the project, many structures have been built both along the S3 Expressway, as well as at local road junctions, including:

- 12 flyovers for the S3 Expressway
- 5 viaducts over the Expressway for local roads
- 3 underpasses
- 13 culverts for wildlife crossings

As part of the project, a total of 10 flyovers were constructed along this stretch of the route using incremental launching methodology. Other bridges were constructed too, some by using scaffolding and others by using prestressed prefabricated beams. ›

Bridge structures under construction on of the S3 Expressway – section WS-52 in the foreground and section WS-54 in the background.

Three locations **six launches**

All of the bridge structures created with incremental launching technology featured continuous reinforced concrete box sections and were designed and executed in the same way.
The hydraulic lifting and launching units, selected to meet the designed traction force required for the incremental launching process, were located on the bridge abutments. The first segment was pulled out using a special lifting system using bar tendons and connected to hydraulic lifting and launching units.
The last segments of all six bridge structures were ballasted in the final launching phase, as there was insufficient friction from the vertical reaction. In addition, behind the last segment of each operation, temporary prestressed concrete blocks with high-strength bars were installed. This solution effectively lengthened the last segment during launching.
Integrated launching bearings (including a side guide), as well as non-integrated launching bearings were used for the launching operations. Where non-integrated bearings were used, independent side guides prestressed to the bridge pillars were also used.
In addition, the scope of the project included fixing the steel launching noses to the bridge deck sections by using post-tensioning tendons and high-tensile strength bars.
The construction schedule was very tight. Realization of the entire expressway project assumed executing all 10 flyovers at the same time, from mid-May to mid-November 2021. For the WS-49, WS-52, WS-54 bridges, executed by BBR Polska, the assumed work schedule was completed according to the program. The remaining two flyovers, executed by others, were only launched at the beginning of 2022.

LOCATION 1

LAUNCHES 1 & 2
WS-49 LEFT & RIGHT CARRIAGEWAYS

NUMBER OF SPANS	10
SPAN LENGTHS	41.25m + 7x50m + 41.25m = 432.50m
PLAN SHAPE	Arc
HORIZONTAL RADIUS	R = 3,800m
GRADIENT	1%
LAUNCH DIRECTION	Downhill
LAUNCHING STEPS	17
SEGMENT LENGTHS	25m-29.60m
TOTAL WEIGHT LAUNCHED	9,625.50t
POST-TENSIONING	BBR VT CONA CMI internal 906, 11/1206 & 1506 and BBR VT CONA CME external 1906

Left: Pictured here at the launch control station, Janusz Koza, BBR Polska Foreman responsible for the works on the WS-49 section. **Right:** Launching of both left and right carriageways gets underway on this section of the project.

LOCATION 2

LAUNCHES 3 & 4

WS-52 LEFT & RIGHT CARRIAGEWAYS

NUMBER OF SPANS	13
SPAN LENGTHS	36.25m + 11x45m + 36.25m = 567.50m
PLAN SHAPE	Arc
HORIZONTAL RADIUS	R = 3,800m
GRADIENT	0.8%
LAUNCH DIRECTION	Downhill
LAUNCHING STEPS	20
SEGMENT LENGTHS	15.48m-30m
TOTAL WEIGHT LAUNCHED	12,240.9t
POST-TENSIONING	BBR VT CONA CMI internal 1206, 1506 & 1906 and BBR VT CONA CME external 2206

Left: Standing beside one of the launching noses is Tadeusz Cieśla who was the BBR Polska Foreman responsible for the WS-52 works.
Right: Launching of both left and right carriageways in progress on this section of the project.

LOCATION 3

LAUNCHES 5 & 6

WS-54 LEFT & RIGHT CARRIAGEWAYS

NUMBER OF SPANS	14
SPAN LENGTHS	37.30m + 12x43.20m + 29.50m = 585m
PLAN SHAPE	Straight
GRADIENT	1.4%
LAUNCH DIRECTION	Uphill
LAUNCHING STEPS	21
SEGMENT LENGTHS	19.80m-28.80m
TOTAL WEIGHT LAUNCHED	12,562.6t
POST-TENSIONING	BBR VT CONA CMI internal 1206, 1506 & 1906 and BBR VT CONA CME external 2206

Left: Pointing towards the array of heavy lifting jacks in the foreground and the launching noses behind them is Mirosław Kurzeja, the BBR Polska Foreman who was responsible for the WS-54 works.
Right: View of the launching operation taken from element 16R and element 14L.

BBR Polska Site Managers Marcin Ornat (left) and Marek Strzoda (right) were tasked with planning, implementing and coordinating for the overall project, while keeping all three teams up-and-running and also going hands-on with construction work themselves.

Weekly cycle

The segments were cast on site on a special casting bed. Our weekly cycle involved installation of bottom slab structural reinforcement, assembly of bottom CONA CMI tendons and then first stage concrete casting of the U-shaped bottom slab and webs. After this, followed installation of the structural reinforcement for the upper plate, assembly of the CONA CMI upper tendons, concreting of the upper slab and stressing of the box cross-section. Then, finally, the incremental launching process could begin.

This well-rehearsed cycle was repeated for each bridge segment until the section was finished. However, each of the flyover structures was different and we had to approach each one differently.

By the end of the project, our teams had incrementally launched a total weight of 69,458t, created a total length 3,182.6m of elevated bridge deck, installed 1,567 CONA CMI/CONA CMX post-tensioning anchorages, used 1,550t prestressing steel for the PT tendons and performed launching operations for 116 segments.

Logistical challenges

Our biggest challenge was actually the huge scale of the task – it was organizationally difficult. Throughout the history of BBR in Poland, we have carried out many simultaneous launching projects. However, the largest to date had involved a project in Łódź, where we launched four structures simultaneously and organized our site staff into two teams.

This more recent project for the S3 Expressway was 50% larger in scope – and represents our biggest ever ILM (incremental launching method) achievement! This required the maximum and optimal use of our resources, maximum efficiency – and absolutely no mistakes!

The execution of six bridge structures at the same time required BBR Polska to involve many specialists – as a result, much careful and close coordination was also needed as work progressed. The experience we had gained from previous projects gave us the knowledge and insight needed to complete this extensive task. The main – and highly experienced – project execution team which had worked on site in Szczepanowice was divided into three independent working groups.

Flyover structure WS-54 after launching.

Due to the large scope of work and the schedule which assumed the parallel launching of all six structures on a weekly cycle, the working groups had to be reinforced with new people. We worked on each flyover in teams of three people who operated the launching equipment, executed technological tasks on two independent lines of the bridge at the same time. In addition, during periods of intensified allied works, related to executing the launch bearings, side guides and external tendons, it was necessary to involve additional working groups.

PT technology

The use of BBR VT CONA CMI internal post-tensioning benefited the project in several ways. One of the major advantages was that it allowed us to complete the task quickly. Having been introduced to the market some 15 years ago, the CONA CMI post-tensioning system has now become a well-established technology which has been proven through many projects, both here and internationally. Alongside this, the ability to stress at low concrete strengths contributed to achieving program times.

New challenges

While this project was certainly a 'first' for us at BBR Polska, we wonder whether we have also set a new world record for the number of structures launched simultaneously! However, the execution of this project on the section of the S3 Expressway was yet another milestone for our family album – and a most interesting experience for BBR Polska. The scale of unusual issues and the complexity of the challenges encountered and overcome here during the project mean that we can look forward to our the next projects with even greater confidence. Increasingly complex projects completed successfully create more opportunities to make new challenges for construction engineers – so, we'll see you later on our next projects!

TEAM & TECHNOLOGY

Client – GDDKiA
Main contractor –Mosty Łódź S.A./ONDE S.A.
Design engineer – TRANSPROJEKT Warszawa sp. z o.o. (load-bearing structures), M3M sp. z o.o. sp. k.
Technology – Incremental launching, BBR VT CONA CMI internal, BBR VT CONA CME external
BBR Network Member – BBR Polska z o.o. (Poland)

Crestawaldbrücke, Sufers, Switzerland PT for renewal of arch bridge

Rebirth of landmark bridge

Designed by renowned bridge engineer Christian Menn, the Crestawald Bridge in Sufers was first opened in 1959. Now, in a project valued at around CHF 93m, this two-hinged arch bridge is being extensively renewed and BBR Network Member Stahlton has been providing expert post-tensioning services.

Aerial view of reconstruction work underway for the Crestawald arch bridge. The adjacent temporary bridge carries traffic on the A13 National Road during the works. Image courtesy of Bundesamt für Strassen ASTRA.

The bridge was one of many new structures which were needed due to the construction of the adjacent Sufers Dam and Hinterrhein power plant. It provides access across the river valley via the A13 national road and runs alongside the face of the imposing dam – the latter was completed in the early 1960s. The years – and meltwaters – had taken their toll on the structure and it was decided to replace the whole bridge except for the arch which has been repaired and strengthened.

Structurally, Crestawald Bridge is a 124m long and 9.4m wide reinforced concrete arch bridge with a 71.5m wide arch and a roadway on a steep gradient.

An auxiliary bridge was built to relieve traffic during the construction phase. Further work is in progress on the A13 national road, which will be protected against falling rocks and flooding by various protective structures.

During the bridge renewal project, 20 BBR VT CONA CMI anchorages (1206, 1906 and 2206) were installed for PT tendons – amounting to a total length of around 780m. The tendons are protected by plastic ducts, which shield them from friction and provide stability. In addition, the anchorages and anchor heads are reinforced with temporary corrosion protection.

While Stahlton's work is complete, the pressure is on to finish the whole project this year and open this strategically important bridge which lies just a few kilometers away from the San Bernardino Pass.

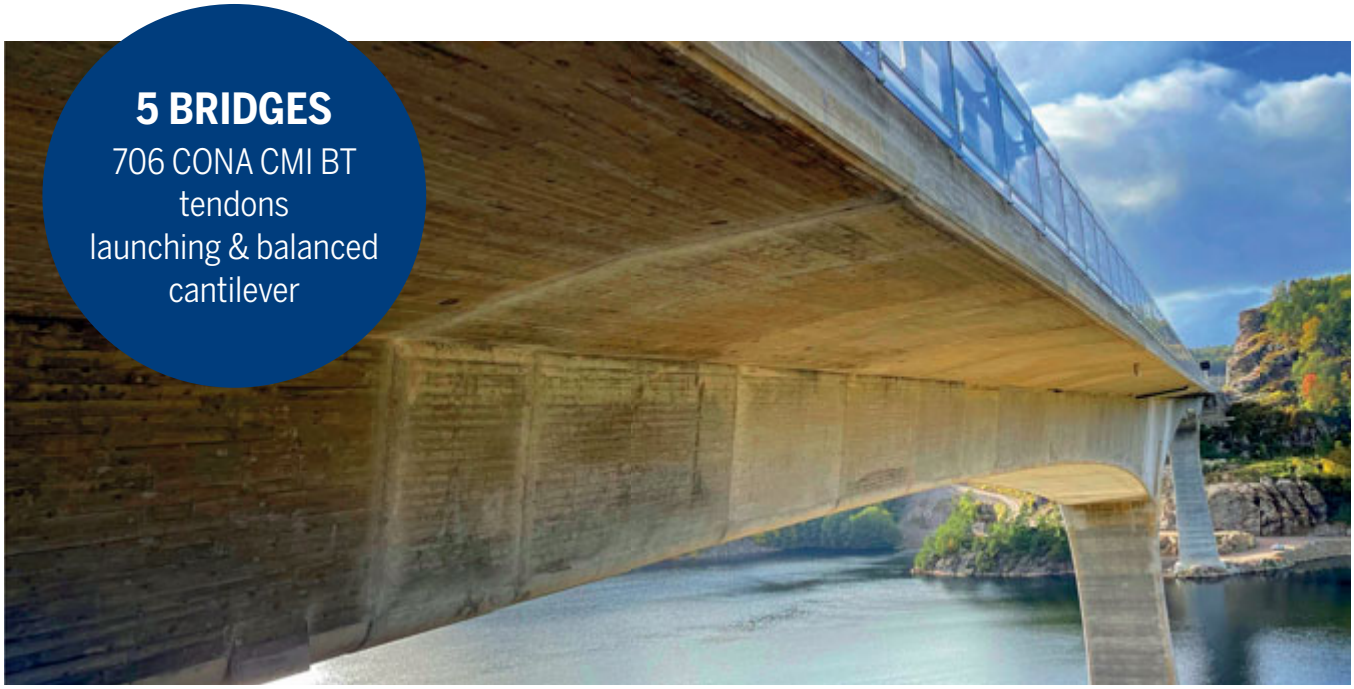
TEAM & TECHNOLOGY

Client – Kantonales Tiefbauamt Graubünden
Consulting engineer – Casutt Wyrsch Zwicky AG
Main contractor – Erni AG
Concrete repair specialist – Hydrojet AG
Technology – BBR VT CONA CMI internal
BBR Network Member – Stahlton AG (Switzerland)

E39 Bridges, Kristiansand vest – Mandal øst, Norway Balanced cantilever, incremental launching & PT

Fab five in the Fjords!

Five fabulous new bridge structures have been constructed in Norway's often bleak but always beautiful fjord landscape. They owe their reality to the special blend of engineering excellence offered by the BBR Network – and latest BBR post-tensioning technology. John Taraldsen and Maciej Michalczyk from KB Spennteknikk AS, the BBR Network Member for Norway, reveal the story behind the project.



1

Scope of works

Our contract consisted of four incrementally launched bridges at Monan (east and west) and Rossevann (east and west) – plus the large free cantilevered Trysfjord Bridge. Originally, KB Spennteknikk AS was invited to tender for the post-tensioning parts of the contract. During the tendering process for the PT work, the question regarding the launching of the Monan and Rossevann bridges came up. Ideally, the main contractor wanted a single source for specialist engineering services, including post-tensioning and expertise in a bridge construction methodology that minimized impacts on the environment.

This was a great opportunity for us to introduce BBR Polska's long expertise and range of equipment for launching such bridges. Another example of how being part of KB Spennteknikk International and the BBR Network offers advantages to Members – and also ensures leading edge international construction technologies and techniques are delivered for their customers.

Contract award

We were delighted when KB Spennteknikk AS was awarded the PT supply and installation contract for all the bridges. In addition, we were also asked for help on the installation of the launching nose for the four ILM bridges.

The competence and experience within KB Spennteknikk and the BBR Network gave us some further advantages which also helped us to win this contract. Together with the BBR VT International R&D team in Switzerland, we developed the helix-only solution for critical areas around the BBR VT CONA CMI anchorage zone. This allows reinforcement to be reduced in the otherwise congested area around the PT anchorages. By the end of the whole project, we had installed a total of 706 CONA CMI tendons in the five bridges, requiring almost 2,000t of steel prestressing strand.

We were in early and close dialog with the main contractor AF Gruppen, the specialist subcontractor Kruse Smith Entreprenør and their consultants to find the optimal solutions for the bridges. Therefore, we were thrilled when BBR Polska also was awarded the contract for launching operations for all four ILM bridges. In fact, you can read about their work on the two bridges at Rossevann in CONNÆCT 2021.

Trysfjord Bridge

While our BBR Polska colleagues were working on the incremental launching projects, we began work on one of the longest cantilever spans in the world – for Trysfjord Bridge.

This elegant bridge has a slender 250m central span and is 537m long in total. It stands 64m above the fjord and is 24m wide.

Our work began after installation of the form traveler. The form traveler was new, so the time before start-up was critical for ensuring all the parts fitted. Next, in such an exposed location, you are reliant on having the right weather conditions. When lifting 12m high formwork into the form traveler, a heavy gust of wind at the wrong moment can cause difficulties. Thankfully, the weather was kind during the installation.

The PT ducts had already been cast into the 'T' heads of the bridge piers, so were ready for insertion of the CONA CMI post-tensioning when the first cast was ready for stressing. With the help of the form traveler, 26 segments in each direction from the 'T' heads were cast in situ, working outwards from each pier. The first two segments were four meters long and all the others were five meters. Both piers were built more-or-less simultaneously and required therefore more equipment and workers on site. To have access to qualified workers in the times of Covid-19 put a lot of pressure on all the companies on site.

Throughout the project, the contractor's huge focus on safety and environmental issues was very much in evidence during installation and day-to-day work. Regular meetings and inspections on site ensured that safe and sound working practices were being adopted and adhered to.

There was a great celebration when the final segment in the center span over the fjord was concreted on 17th February last year.

Innovations & advantages

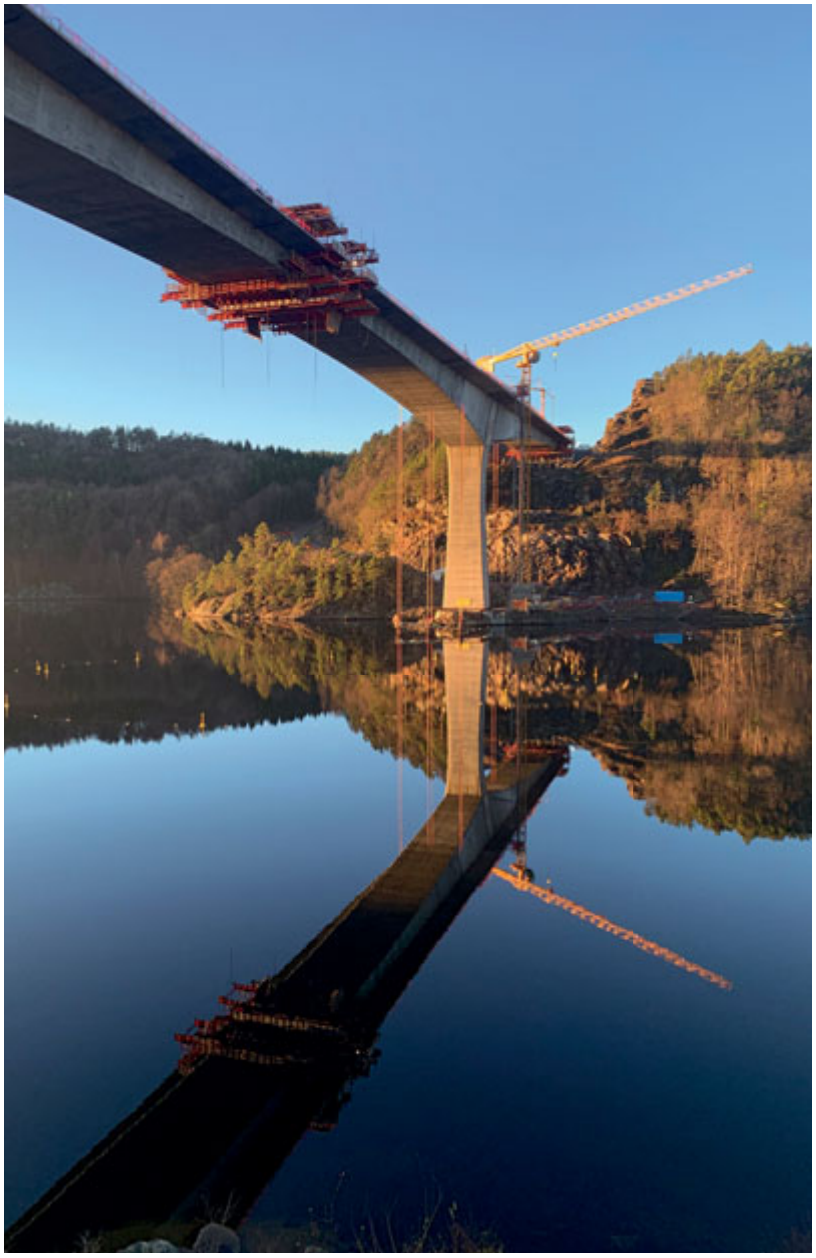
This was a paper-free design process whereby the entire bridge was built in 3D before being built in concrete. This approach has allowed optimization of design features harnessing materials savings and promoting a sleek yet durable design, while reducing CO_2 emissions. Also, the use of BIM improved communication among members of the project team – wherever they were located – because with everyone using the same system, updates were available to all at the same time.

Our contract was underway at the time that the global Covid-19 pandemic began, bringing with it travel restrictions with borders being closed all around the world. Managing progress on this project was a particular challenge because there were so many foreign companies and workers involved. However, with the benefit of hindsight – and the great professional satisfaction of having completed our work on all five structures to the highest possible standards – we can honestly say that it was handled very well indeed. Teamwork was a notable feature of this project, even from the earliest stages. This collaborative and cooperative attitude from all involved has ensured the delivery of the bridges to the right quality and at the right time.

1 The completed 537m long Trysfjord Bridge with its 260m central span – one of the longest single spans in the world. Image courtesy of Nye Veier AS.
2 The cantilever closing pour was in February 2022, after the final segment was concreted. Image courtesy of Mikael Osen.

TEAM & TECHNOLOGY

Client – Nye Veier AS
Main contractor – AF Gruppen AS
Specialist contractor – Kruse Smith Entreprenør AS
Consulting engineer – Norconsult AS
Technology – BBR VT CONA CMI internal, incremental launching, balanced cantilever, pot bearings
BBR Network Member – KB Spennteknikk AS (Norway)



2

New Access Bridge, Île Saint-Denis, France Post-tensioning for steel bridge

Night at the ballet

In a series of maneuvers that were choreographed as precisely as any ballet performance, a new bridge over the River Seine was lifted into position one evening last October. Designed as a 'soft' bridge, for buses, cyclists and pedestrians, this structure is a vital component of the redevelopment of this area for the 2024 Paris Olympic Games and beyond. This once-in-a-lifetime event was witnessed by local people and those associated with the project, including Jérémie Baumgartner, Director of French BBR Network Member ÆVIA Câbles et Manutention, part of Eiffage Génie Civil, who now takes up the story.

Even after many years as a civil engineer and supporting the creation of countless different types of infrastructure, it was immensely exciting to see this new bridge being raised from the barge into its permanent position. It is certainly not every day that a new bridge is constructed over our most famous waterway – the River Seine.

Leap towards the future

As well as satisfying the need for connectivity between the Athletes Village during the upcoming 2024 Paris Olympic Games, this bridge represents a leap towards the future too. After the Games, the accommodation for athletes will be remodeled to create a lively neighborhood, along with green spaces for leisure and public open spaces – the new bridge will be the centerpiece of this scheme.

Teamwork & planning

As mentioned in CONNÆCT 2022, we have been working alongside our colleagues from all around Groupe Eiffage, the main contractor for this project. Many months of planning and preparatory work had taken place before any work on site was commenced – let alone, before this spectacular evening event could be contemplated.

The bridge has a prestressed deck, a composite frame and a total length of 138m. At its extremities, it rests on two abutments on either side of the river. On the Île Saint-Denis side there is a front wall abutment (Abutment C0) and on the other side there is a gravity abutment (C2) connected to an intermediate pier (P1) where the supports for the bridge crutches are located. The C2 abutment structure was especially complex, as it must accommodate not only the supports for the steel bridge, but also the live loads – from buses and crowds – that will be imposed during its service life.

The steel structure itself had been manufactured by Eiffage Metal in a riverside dock, downstream in Gennevilliers. It was then loaded onto a barge and, after an 8km 'cruise' along the Seine, it arrived in its final location.

1

2

Post-tensioning work

Almost as soon as the new bridge superstructure had been placed, the thoughts of the ÆVIA Câbles et Manutention team turned to their next task – installation of external post-tensioning for the steel bridge.

Earlier, our team had installed 24 BBR VT CONA CMI tendons for the bridge abutment (C2) on the right bank of the river. The cover slab was post-tensioned using eight rows of 40m long 42-strand PT tendons to allow the transmission of forces from one end of the abutment to the other. The uncommon tendon size meant that we had to source a special stressing jack. Here, we really appreciated support from BBR HQ and other BBR Network Members – especially Austrian-based KB VT who prepared and loaned us the perfect-sized jack for the stressing operation.

The bridge deck is made up of four longitudinal box girders to accommodate the prestressing of the deck, linked transversely by standard bridge parts and by transverse box girders at the right of the abutments and in the nodes of the triangulated zone for the crutches, counter-crutches and deck functions.

As this edition of CONNÆCT goes to print, we will be installing the eight 100m-long CONA CME 3706 external tendons with monostrands for this slender-profiled steel bridge.

The tendons are comprised of individually sheathed unbonded monostrands in grout-filled ducts which, thus, have several layers to protect the installation against corrosion. Structurally, the external PT tendons will be used to cope with the negative bending moments and to give continuity to the deck giving it stiffness and making it monolithic. Ducting for the tendons was installed during fabrication of the bridge deck and leak-tightness tests were performed at each stage of deck assembly.

New national treasure

This has been an extraordinary project, not only because of the exquisitely detailed engineering design that it has involved, but also because of the tremendous spirit of collaboration that has developed between all members of the professional team. It is somehow fitting, 100 years after the death of Gustav Eiffel – famous for construction of the Eiffel Tower – that Groupe Eiffage, the company which continues his work, should be at the very heart of the realization of this latest steel structure. Just as Monsieur Eiffel embraced the new technologies of the age, we have also incorporated leading edge technologies and techniques of today to create this elegant new bridge. We hope that it too may one day become a national treasure.

1 The steel deck for the new bridge across the River Seine was raised into position from the barge which had delivered it to the site.
2 Eight CONA CME monostrand external post-tensioning tendons will be installed in the bridge deck box girders in order to make this slender structure monolithic and to counter negative bending moments.

Images courtesy of Cédric Joie, SAP Photographie.

TEAM & TECHNOLOGY

Owner/client – Le Conseil départemental de Seine-Saint-Denis
Designer – Artelia Ville & Transport
Architects – Lavigne & Chéron + Philippon Kalt
Main contractor – Groupe Eiffage
Technology – BBR VT CONA CMI internal, BBR VT CONA CME external unbonded with monostrand
BBR Network Member – ÆVIA Câbles et Manutention (France)

Green light for rail schemes

As cities around the world move towards greener, more sustainable travel solutions, BBR Network Members have been awarded contracts for important new rail connections. All of these high profile schemes feature European approved BBR post-tensioning technology.

1

2

1 The new Cairo Monorail project is being realized with the expertize of local BBR Network Member ESPT – and of course, BBR post-tensioning technology.
2 Trains will be able to run at 230km/hr on Egypt's new 2,000km high-speed railway network. The scheme's project manager and rail technology specialist, Siemens Mobility, will supply a total of 186 trains, including passenger and freight trains. Image courtesy of Siemens Mobility.
3 Siemens Mobility will be supplying three different types of train to run on the Cairo High Speed Rail lines. Image courtesy of Siemens Mobility.
4 Visualization of the Jurong East Integrated Transport Hub, one of three JRL contracts in Singapore for which BBR Construction Systems is providing post-tensioning expertize. Image courtesy of China Communications Construction Company Ltd (Singapore Branch).

In Egypt, local BBR Network Member ESPT is participating in two massive projects and in Singapore, BBR Construction Systems is providing special expertise for the construction three packages on the Jurong Region Line.

1 High-speed rail network, Egypt

The new multi-billion Euro high-speed rail scheme in Egypt aims to connect 60 cities throughout the country with a 2,000km state-of-the-art network. The integrated system will create the sixth largest high-speed rail network in the world and will be accessible by 90% of Egyptians. It is being delivered by a consortium of Orascom Construction, Siemens Mobility and Arab Contractors who are responsible for the design, installation, commissioning and maintenance for a period of 15 years of the rail system on an EPC+ Finance basis. The new network is divided into three lines, each of which has a clear headline objective:

- Attractive, electrified commuter system for Greater Cairo – with 660km of track connecting the port cities of Ain Sokhna on the Red Sea to Alexandria and Marsa Matrouh on the Mediterranean coast.
- Support for urban development to the south – with a line around 1,100km long running between Greater Cairo and Abu Simbel near the Sudan border.
- Easing freight transport to Egypt's inland areas – this line will cover 225km, connecting the archaeological World Heritage sites in Luxor with Hurghada and Safaga harbor by the Red Sea.

Over 4,250 BBR VT CONA CMI BT post-tensioning tendons will be installed and stressed for the first phase of the project, during an eight month period – where, of course, the expertize of the ESPT team will play a crucial role.

As well as saving millions of passengers up to 50% on their travel time, the new high-speed rail network will positively impact the economy and increase quality of life, while cutting carbon and reducing air emissions by over 70% compared to car or bus transportation.

2 Cairo Monorail

Cairo is the largest city in Africa and currently has a population of over 20 million people. With one of the world's youngest demographics, the population of Egypt is forecast to grow by some 50% – from 100 million to 150 million – by the end of the century. Thus central government devised a series of new population centers away from the already congested Cairo streets. The Cairo Monorail project will deliver public transport links between metropolitan Cairo and the New Administrative Capital, as well as 6th October City, to the east of Cairo. With two lines covering around 100km, it will be the longest driverless monorail system in the world. A €2.7bn contract to design, construct, operate and maintain the two lines was awarded to a consortium of Alstom, Orascom Construction and Arab Contractors. After the construction phase is completed, the Alstom-led consortium will provide 30 years of operation and maintenance services for both lines.

Construction involves the installation of overhead precast concrete guideway beams in a highly urban environment. Much of the alignment has been designed to run along major highways and moves between the median of existing roadways and the shoulders to avoid large highway crossings or accommodate stations, before returning to the medians. There are numerous utilities and existing structures that must be avoided – and even some for which construction got underway after the contract was approved.

As well as the new high-speed rail system, the ESPT team is also supporting this new monorail system. Here, they are supplying technology and expertise to build stations on the 6th October City line. The work involves installation of BBR VT CONA CMI BT post-tensioning to speed construction of two stations.

After the lines have been completed and commissioned, passenger services will be provided by 70 fully automated, driverless Alstom INNOVIA monorail 300 trains, which feature four cars each. Made of extruded aluminum panels, the trains are corrosion-resistant and recyclable. ›

3 Jurong Region Line (JRL)

Meanwhile, more than 8,000km to the East, BBR Construction Systems Pte Ltd has been contracted as the PT specialist for three of the Jurong Region Line (JRL) packages.

First announced in 2013, the Jurong Region Line (JRL) is Singapore's seventh Mass Rapid Transit (MRT) line and is in the western part of Singapore.

Spanning over 24km, JRL is an elevated line with 21 stations and three interchange stations with connections to existing MRT lines. Its main line runs south west from the existing MRT station in Choa Chu Kang with three branches towards Pandan reservoir in the east, Jurong Pier in the south and within Nanyang Technological University (NTU) in the west.

Being an elevated line, JRL has its tracks above existing roads, heavily utilized junctions and even crossing expressways. With the safety of road users in mind, the JRL tracks are designed to be precast segmental box girders to allow for erection by the span-by-span or balanced cantilever construction methods.

Post-tensioning is needed for the balanced cantilever method of erection as the compressive force induced into the structure after tendon stressing allows for the balancing of the weight of the structure and holds the precast segments in place. The use of post-tensioning also allows for smaller box girder sections while still being able to sustain the required loads from the trains during its service life.

The smaller concrete sections, while aiding with maintaining of vehicular height clearance below the track and being more aesthetically pleasing, poses many challenges to the installation and fitting in of PT tendons. The small edge distances required by the BBR CONA CMI internal anchorage offer a great advantage here. This permits the sizes of stressing blisters within the precast segments to be minimized and also reduces the weight of the structure, as well as allowing for greater space within the box girder for future maintenance.

While construction continues apace on these three important rail schemes, you may look forward to more detailed reports about their progress in future editions of CONNÆCT.

TEAM & TECHNOLOGY

1 HIGH SPEED RAIL CAIRO, EGYPT

Client – National Authority for Tunnels (NAT)
PPP consortium – Orascom Construction, Siemens Mobility and Arab Contractors
Technology – BBR VT CONA CMI internal
BBR Network Member – ESPT (Egypt)

2 CAIRO MONORAIL, EGYPT

Client – National Authority for Tunnels (NAT)
PPP consortium – Alstom, Orascom Construction PLC & The Arab Contractors Co. Consortium
Main contractor – Orascom Construction PLC & The Arab Contractors Co. JV
Technology – BBR VT CONA CMI internal
BBR Network Member – ESPT (Egypt)

3 JURONG REGION LINE – CONTRACT J105

Client – Land Transport Authority
Main contractor – China Railway 11 Bureau Group Corporation (Singapore Branch)
Design consultant – WSP Consultancy Pte Ltd
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Construction Systems Pte Ltd (Singapore)

JURONG REGION LINE – CONTRACT J106

Client – Land Transport Authority
Main contractor – China Communications Construction Company Ltd (Singapore Branch)
Design consultant – WSP Consultancy Pte Ltd
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Construction Systems Pte Ltd (Singapore)

JURONG REGION LINE – CONTRACT J120

Client – Land Transport Authority
Main contractor – China Communications Construction Company Ltd (Singapore Branch)
Design consultant – KTP Consultants Pte Ltd
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Construction Systems Pte Ltd (Singapore)

3

4

Vinjan Viaduct, Slovenia
Balanced cantilever construction

Elegant rail infrastructure

Work has just begun on the Vinjan Viaduct, a key component of the 27km-long second track of the Divača-Koper railway scheme in Slovenia. The seven span viaduct will be 620m long and 9.6m wide, with pier heights of up to 55m. The prestressed concrete box girder superstructure will be constructed using the balanced cantilever method. BBR Adria will be providing BBR VT CONA CMI internal post-tensioning for the balanced cantilever construction. We look forward to hearing more about this stunning project in the next edition!

TEAM & TECHNOLOGY

Client – Ministry of Infrastructure, Slovenian Infrastructure Agency
Designer – Ponting – Pipenbaher Consulting Engineers
Technology – BBR VT CONA CMI internal, balanced cantilever
BBR Network Member – BBR Adria d.o.o. (Slovenia)

The first of the twin carriageways for the new Çayırhan Bridge – pictured here just before it was completed.

Çayırhan Bridge, Turkey Cantilever construction

Cantilevering to a new record

Construction history is being made in Turkey with the building of the new Çayırhan Bridge – it will be the country's first cantilever bridge with inclined piers. Kadir Serden Hekimoğlu of local BBR Network Member Kappa presents a brief overview of the project.

It is the first time that a bridge has been built in Turkey with inclined piers and using cantilever construction and we, at Kappa, are delighted to be part of the project team. This elegant 270m-long new bridge has a maximum span of 145m over the waterway. Çayırhan Bridge, for the 4th Regional Directorate of Highways, is located on the Beypazarı Nallıhan Provincial Road close to Nallıhan Bird Sanctuary. While the bridge connects Ankara and the Nallıhan region, it was also designed to protect the important wildlife zone in which it is being built. In addition, when the bridge is completed, it will add value to the region while providing a comfortable and safe road.

Our sister company CEKA has customized the form traveler we provided to conform to specific project requirements. Meanwhile, our team is operating the form traveler and executing the post-tensioning for the twin deck bridge. For each carriageway, we are moving each form traveler 16 times – so a total of 33 movements including the key segment before each bridge span is closed. We are using the BBR VT CONA CMI internal system with 19 strands to provide the necessary post-tensioning for the bridges. Before construction of the cantilever section, eight tendons were stressed in the section above the temporary scaffolding. In the cantilever part of the bridge, 44 tendons in the upper span and 16 tendons in the lower span were stressed by the end of 2022. A further 14 tendons will be stressed after concrete for the key segment is cast, thus closing the span.

Work on the second carriageway is underway and the project is expected to be completed by March 2023. Then we will rejoice that we have delivered a high-quality structure, celebrate the excellent teamwork that has made it possible – and look forward to our next opportunity to help in the creation of another unique structure.

TEAM & TECHNOLOGY

Owner – 4th Regional Directorate of Highways Ankara

Main contractor – Ankara İnşaat Tic. Ve San. Ltd. Şti., Açılım İnşaat Tic. Ve San. Ltd. Şti.

Technology – BBR VT CONA CMI internal, free cantilever

BBR Network Member – Kappa (Turkey)

SAG Tarnów Bridge, Poland Record-breaking cantilever construction

Most reach in Poland

Two river bridges, around 12 years and 500km apart. Back in 2011, Grudziadz Bridge set a record for cantilever construction in Poland, now a new record has been created with the SAG Tarnów Bridge. Both were built with the help of specialist expertize from BBR Polska who, among many other techniques, have pioneered cantilevering construction methods for their local market.

TEAM & TECHNOLOGY

Owner – Zarząd Dróg Wojewódzkich w Krakowie
Designer – M3M Sp. z o.o. sp. k. + Highway Sp z o.o.
Main contractor – Metrostav Polska S.A.
Superstructure contractor – Makax Sp. z o.o.
Technology – BBR VT CONA CMI internal, free cantilever
BBR Network Member – BBR Polska z o.o. (Poland)

When it was completed, Grudziadz Bridge had the longest concrete beam span – 180m – ever constructed in Poland by the cantilever method. Just a few months ago, this record was overtaken by a new bridge at SAG Tarnów which has a maximum beam span of 185m.
Located in the south of the country, the new SAG Tarnów Bridge is an 815m long structure which carries the DW-973 highway over the Dunajec river. It has 12 spans varying from 30m to 185m long and has been constructed using CONA CMI internal post-tensioning.

At the time it was built, Grudziadz Bridge was breaking new ground, as cantilever construction was uncommon in Poland. The whole bridge comprises two 17.35m wide parallel structures, each of which is over 1,950m long. The 400m central section across the river was built using free cantilevering methodology and features the then record-breaking 180m main span. Meanwhile, the northern and southern approach structures were constructed using incremental launching and the whole 1,950m long twin deck bridge was prestressed using BBR post-tensioning tendons. There's more information in CONNÆCT 2011 about this and some further bridges constructed by the team.
BBR Polska is now looking forward to extending its reach even further – and its next opportunity to exceed even their new record set at SAG Tarnów.

2022 – the new SAG Tarnów Bridge nears span closure and has now overtaken BBR Polska's earlier record for constructing the longest cantilever span in Poland.

2011 – Grudziadz Bridge, a milestone in cantilever construction, pictured here just before span closure took place.

Special News Report Interview with Chairman of BBR Saudi Arabia

Driving quality & innovation

Only five years after becoming a BBR Network Member, BBR Saudi Arabia has captured 60% of the growing post-tensioning market in the region, but has no intention of just stopping there. Chairman of BBR Saudi Arabia, Nghaimish AlHarbi shares some insights into the local market – and his company's success and strategy for the future.

1

What's happening in the Saudi Arabian market?

Many remarkable accomplishments have been achieved In the five years since Vision 2030 was publicly announced to support the Kingdom's economic diversification objectives and to build a prosperous future for the Saudi people.

The most notable gains have been in the housing sector, where home ownership has increased to 60% compared to 47% five years ago. The successes have also extended to the employment sector. In December 2021, the number of Saudi employees in the private sector topped 1.9 million for the first time, demonstrating the efficacy of government policies and efforts to provide jobs for Saudis in the private sector.

The Saudi construction market is driven by Riyadh's Vision 2030 national development, which includes several megaprojects.

All these achievements and aspirations must now also consider the stated aim of reaching net zero carbon by 2060, as announced by HRH Crown Prince Mohammed bin Salman at the inaugural Saudi Green Initiative (SGI) Forum in 2021. The initiatives described place Saudi Arabia at the forefront of the battle against climate change.

How do you see the market & use of BBR technology developing?

The Saudi construction market is projected to grow significantly as a result of Vision 2030. The construction market encompasses a wide range of activity that includes upcoming, ongoing and growing construction projects in various areas, such as superstructures in the residential, commercial and industrial sectors, along with infrastructure construction.

The application in Saudi Arabia of BBR post-tensioning – with all its inherent advantages – has been frequent in recent years. The scale of the projects that the Kingdom is building under its Vision 2030 strategy means that they are likely to benefit from the incorporation of post-tensioning, at least for certain elements.

Therefore, we are focused on maintaining our position as the market leader for post-tensioning and associated techniques – not only among existing customers, but also for new ones as the Kingdom continues to tackle its comprehensive modernization and growth plans.

3

رؤية VISION 2030
المملكة العربية السعودية
KINGDOM OF SAUDI ARABIA

Megaprojects in Saudi Arabia

Within Riyadh's Vision 2030 national development plans are several massive megaprojects.

Neom, meaning 'new future', is a large-scale urban project which is planned to cover 10,230 square miles on the Red Sea in north-western Saudi Arabia's Tabuk province. It consists of three individual megaproject cities – OXAGON, a new port city and the world's largest floating structure; TROJENA – a mountain tourism resort; and THE LINE – a 170km long, 200m wide zero carbon linear city. Further large-scale projects include Qiddya Entertainment City, KAR Gateway and The Red Sea project.

Visualizations of cities within Saudi Arabia's Vision 2030 scheme include Neom's The Line (top) and the KAAR Gateway project (bottom).

2

What investments have you made in the business to enable it to best capitalize on the market?

After earlier successes in Jeddah, we have now extended our reach by investing in and opening new offices in Riyadh and Dammam to provide local services to customers in those cities. In addition, we have already invested in the Gulf region – in Qatar and Bahrain – and we have also opened technical support offices in Lebanon and Jordan. Our large base of clients includes public and private organizations. Furthermore, we are working on opening a factory to manufacture ducts for post-tensioning systems.

We have also invested heavily in people and have grown the business from 21 to 125 staff in the last five years. It's a well-known expression that 'people do business with people' – and this is why we have placed special emphasis on hiring the right people. Our team of highly qualified professionals are all dedicated to delivering the high standards of service expected by our customers today.

Another significant investment in our business is our membership of the BBR Network. To have access to European approved post-tensioning and further technologies and techniques – and, actually, so much more than this – is a major advantage for our company.

Alongside these elements, we have also achieved registration to ISO 9001 status for our business in early 2022, thus aligning it clearly with international quality standards. Securing internationally recognized accreditations will continue to be part of our strategy of continued investment in our business.

4

What role do you see for BBR technology & techniques?

BBR technologies and techniques are set to play an important role in the economic uplift and future development of the Kingdom of Saudi Arabia. Certainly, the cost and time-savings attainable with BBR post-tensioning are very attractive, but the proposition becomes totally compelling when you combine this with enhanced quality of material, the finished construction project overall – and reduced carbon emissions.

Increasingly, architectural designs are becoming more adventurous as customers seek a 'signature building' – and we offer support here too. The skilled application of post-tensioning can even help to realize ambitious landmark structures and contribute to their buildability. There's nothing we like better than turning a dream into reality!

In a market which has relied on traditional RC construction, we continue to explain and promote the benefits of adopting a post-tensioned approach to construction. The success of our strategy is demonstrated by the number of repeat customers on our books – once they have experienced the benefits, they come back for more.

For example, we have installed BBR post-tensioning for many multi-storey buildings where it has allowed wide open, column-free spans, sleeker or elegant design profiles and reduced the amount of construction material needed for the project – with time and cost savings as well. Naturally, PT technology has also been used for bridges – although our market here has yet to embrace the full range of advantages offered by BBR technologies and techniques for infrastructure. Of course, the ability to adapt existing structures through renovation and retrofitting (MRR) techniques is also facilitated by the use of specialist construction technologies. Most recently, we've adapted existing cinema and gym buildings using CFRP and external post-tensioning and have, effectively, given them new and useful lives. We envisage strong growth for our services in this area too over coming years.

5

What are the advantages of being a BBR Network Member?

From my perspective, the most significant advantage of being a member of a network is support. Added to this, the sharing of information, the opportunity to discuss current challenges and emerging trends in all aspects of the industry is of great value. Without doubt, the greatest resources today are the people within our networks. A further benefit of belonging to a membership-based network is the opportunities this presents to gain more business and growth.

Specifically, the BBR Network is an important international group of people who all base their businesses on specialist construction engineering, they have years of experience and together have constructed some of the world's most challenging structures. Of course, the technology which they use is also the result of many years of experience – and is constantly refined and updated, incorporating technological advances and global feedback, by the BBR HQ R&D team.

We really appreciate the support we have had from BBR HQ who always respond quickly to our needs, whether it's about technical or supply issues. The training sessions organized by members of the BBR HQ team have also helped us to provide first class services for our customers. We love being part of the global dialogue with other Members and greatly respect their achievements.

What are your short & long term strategic plans?

Clear objectives determine your growth in any field. During my time as a student, I didn't place much emphasis on goals and objectives. Eventually, however, I realized how critical it is to set goals. For our business, the short-term goal is to increase our work metrics, such as the quality, quantity and efficiency of the work while continually innovating, developing and adopting. Overall, our commitment is to build long-term relationships with our customers by exceeding their expectations and gaining their trust. The whole team here is looking forward to continuing our success – and to helping our customers achieve even greater successes of their own too.

BETTER DESIGN & PRODUCTIVITY WITH CONA CMF

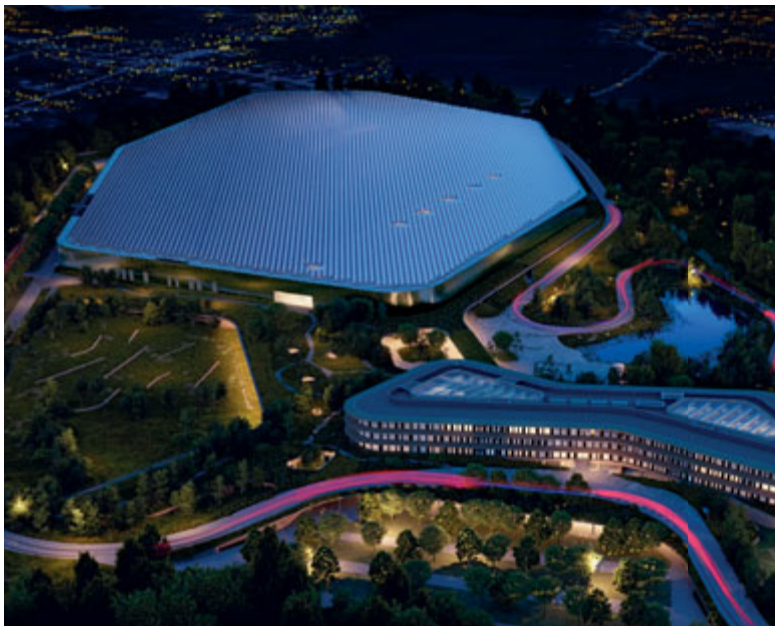
Many of the projects shown here were realized with CONA CMF post-tensioning which offers many advantages to all stakeholders:

- Reduces congestion in the anchor zone with better performance.
- Only requires the minimum anti-bursting steel possible across the whole range – saving you time and money.
- Lowest concrete strength stressing – 21/26MPa concrete strength at stressing → 3 days to apply full stressing → speed up construction cycles.
- Lowest slab thickness on the marketplace means that you swipe your competitor out of the picture by saving invaluable time and material on-site.
- Widest range in the market place, using individual universal mono barrel anchorage heads.
- Tendons are not only restressable, but they are also replaceable.

6

7

1 The 130m tall Ajdan Rise tower is a landmark on the Khobar Seafront. Realized with CONA CMF post-tensioning, it covers an area of 6,826m² and offers usable space of 150,000m².
2 The application of CONA CMF post-tensioning technologies, such as for the Kempinski Hotel in Al Madinah, have enabled greater productivity on site as well as structural design advantages and savings.
3 Nghaimish AlHarbi, Chairman, BBR Saudi Arabia.
4 BBR Saudi Arabia has invested heavily in hiring and retaining the right people – the business has grown from 21 to 125 staff in the past five years.
5 The BBR Saudi Arabia team is working on the Al Safiyyah Museum and Park project south of Al Madinah. It will feature a cultural park and exhibition area, commercial, underground museum, leisure and associated facilities. Pictured here are an artist's impression of the finished structure.
6 Another current BBR Saudi Arabia project is Solitaire Mall. Known as the jewel of Riyadh, it is a 65,000m² retail mall, consisting of a number of pavilions. Again, CONA CMF post-tensioning is being used for this project.
7 Another of the projects in the region is the Wasat Al Madinah Mall – a 250,000m² retail and leisure scheme featuring CONA CMF post-tensioning.



1

2

Rimac Campus, Croatia CONA CMM for automotive plant

Monostrand for motoring

Construction of an exciting new automotive production facility is underway in Sveta Nedjelia, near Zagreb. Predrag Presečki of BBR Adria describes the background and the role that BBR post-tensioning is playing in the realization of the Rimac Campus.

1 Visualization of the new Rimac Campus near Zagreb which will be one of the largest automotive R&D and production complexes in Europe.
2 Construction underway on the 21m span bridge, part of the car museum within the 70,000m² production plant. CONA CMM monostrand unbonded post-tensioning has been installed to achieve the minimum height requirements of the architectural design.

TEAM & TECHNOLOGY

Owner/developer – Rimac Automobili d.o.o.
Architect – Studio 3LHD d.o.o.
Main contractor – Facies d.o.o.
PT design – Studio Arhing d.o.o., BBR Adria d.o.o.
Technology – BBR VT CONA CMM monostrand
BBR Network Member – BBR Adria d.o.o. (Croatia)

With a total area of 200,000m², the Rimac Campus will be one of the largest automotive development, research and production complexes in Europe. After starting Rimac Automobili in 2011, founder Mate Rimac has grown the business from a specialist component manufacturer to a series production hypercar and technology company with a team of over 1,300 employees across several sites. The Rimac Campus is the company's dream location and will open the door on a whole new era of automotive R&D and production.

In addition to Rimac Nevera hypercar production, the campus will develop and design electric drive systems for both Bugatti and Rimac models, as well as for the needs of other manufacturers. The anticipated financial investments in the project exceed €200 million.

PT meets vision

At the heart of the new campus is a 70,000m² production plant. Inside the hall, there is a 21m span bridge – part of the car museum – and a mezzanine office space measuring 200m x 27m.

It was vital that the beams should be of minimum height, thus a post-tensioned approach has been adopted for the bridge and the mezzanine.

In the transverse direction, the mezzanine slab has been resolved by reinforcing it with shallow wide beams at 12m intervals, creating spans of 2m x 13.5m. The outer longitudinal lines lose every other column, so the spans here are doubled to 24m. The solution has been provided by installing post-tensioned edge beams above the 70-180cm panel. BBR VT CONA CMM monostrand unbonded PT tendons have been installed for the panels.

Work on the production hall began in early 2022, and the planned completion of this first phase of the campus is in 2023.

It has been a privilege to share the excitement of this visionary project and we wish the Rimac Automobili team every success in their new 'dream home'.

Skyline Belgrade, Serbia CONA CMM for landmark building

Boosting productivity in Belgrade

The Skyline Belgrade project will deliver a unique and luxurious complex of impressive size, in a prestigious location in the city center. Its blend of elegant and sophisticated architecture is being realized by harnessing the benefits of latest European approved post-tensioning technology, reports Predrag Presečki of BBR Adria.

The upper 17 floors of Tower B of the Belgrade Skyline development are elliptical in shape, while the first 10 floors are rectangular. To reduce slab deflection and shear forces, BBR Adria are installing CONA CMM monostrand unbonded PT tendons.

Following the site's sloping topography, the project was conceived as a complex of three towers – with a 129m high central office tower (Tower C), a smaller 64m tower (Tower A) and a 93.7m middle tower (Tower B).

This residential and commercial complex covers a total area of 68,000m^2 and its open concept takes full advantage of the location. The combination of cylindrical rounded towers and interrupted rectangular structures has created a thoughtful solution. This complex on top of the ridge, right next to the highway, will become a new architectural landmark for Belgrade and set a new spatial and height benchmark for the city. The planned financial investment for this complex amounts to more than €200m.

Progress on site

Towers A and C have already been completed and the 27-story Tower B is now under construction. A post-tensioned approach has been adopted for the latter. This choice was made primarily to reduce slab deflection and shear forces – the maximum span is 10m. PT technology is being used together with a constant slab thickness of 24cm. The first 10 floors with an annex measure 22m x 46m, while the upper 17 floors are elliptical in shape and each covers an area of 22m x 35m.

Benefits of post-tensioning

The slabs are being post-tensioned with BBR VT CONA CMM monostrand unbonded tendons – amounting to 106t of prestressing steel. Work on Tower B began in March 2022 and completion is scheduled for April 2023. In addition to a significant reduction in deflection compared to the classically constructed Towers A and C, time-savings were also delivered. An 11-day cycle time was achieved for the execution of 630m^2 of an elliptical slab.

We are delighted to be contributing latest European approved post-tensioning technology to this magnificent project – a great technical solution and a boost for on-site productivity.

TEAM & TECHNOLOGY

Owner/developer – AFI Group Global, AFI Europe
Architect – MYS Architects Israel
Main contractor – EX ING B&P d.o.o.
PT design – Mašinoprojekt KOPRING A.D., BBR Adria d.o.o.
Technology – BBR VT CONA CMM monostrand
BBR Network Member – BBR Adria d.o.o. (Croatia)

Piled & suspended ground slabs, Dunedin, New Zealand
Solutions with CONA CMF

Double in Dunedin

Delivering a commercial floor that's safe, cost effective and delivers on performance is tricky when faced with poor ground conditions. This was the challenge facing New Zealand's BBR Contech when installing floor slabs for two of Australasia's leading brands, both in Dunedin. Peter Higgins tells of how a complex approach was necessary whereby the post-tensioned slabs on ground were installed on ground improved by piles.

1 Improving shopping experience: PlaceMakers

PlaceMakers is the largest supplier of building materials and hardware in New Zealand – and a popular weekend destination for Kiwi do-it-yourself-ers. It has a nationwide presence of 62 stores that, combined, employ more than 2,000 people to sell more than 74,000 product lines. It also manufactures frames and trusses at eight manufacturing plants around the country.

In 2022, PlaceMakers' Dunedin moved to a new and larger location, mainly in response to significant changes in the market that included a rise in online shopping, an increase in trade customers and a doubling in sales in the previous 12 years. The aim was to take a 'no compromises' approach to the whole customer journey, providing both amateurs and professionals with an outstanding shopping experience. There was just one snag – the ground conditions of the store's new site were poor, with likelihood of settlement. The site's previous use as the Carisbrook sports ground only imposed limited loadings over the sports pitch area of the site with the permanent grandstands being piled.

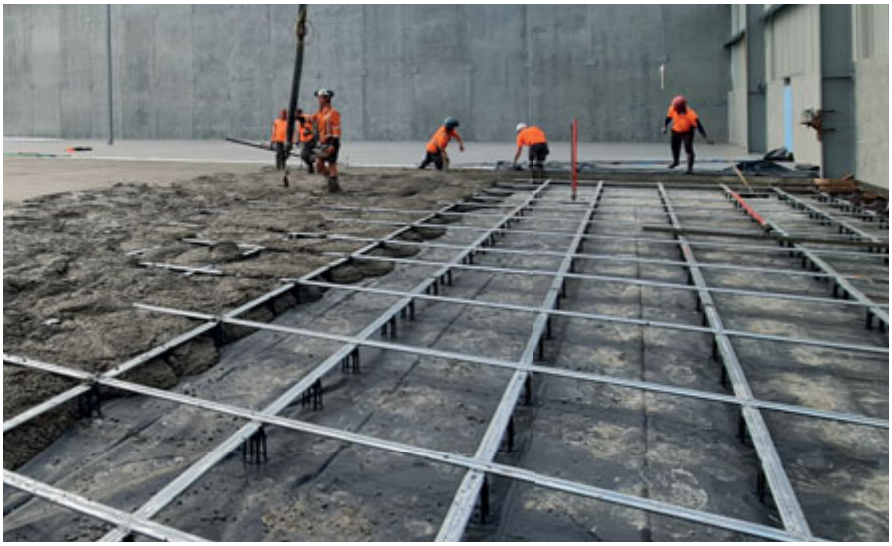
To address the ground condition issue, the BBR Contech team worked with main contractor Calder Stewart to design and install a PT floor slab solution that would deliver the resilience required for often heavy loads.

The first step was to drive 128 piles into the ground, spaced at about 4m centers. This was followed by the installation of two post-tensioned, 230mm-thick suspended slabs that sat either side of the office/administration area – one of 902m^2 for the store's trade hall, and the other of 1,758m^2 for a dedicated, COVID-19-friendly, drive-through 'Click and Collect' zone – the first of its kind in New Zealand.

The new store opened for business in July 2022, providing innovative features such as a landscaping yard for gardeners and a dedicated paint, adhesive and sealants area for the trade. It also acknowledges the former hallowed ground of Carisbrook by displaying a collection of memorabilia!

1

2



3

Smart approach to slab design

BBR Contech undertook the design of the suspended slabs on grade using specialist software which has the capability not only to address the post-tensioning and conventional reinforcement, but also to assess the design criteria.

All of the slabs were founded on an engineered fill raft with intermediate pile supports. Governing load cases for industrial warehouses tend to be racking post loads and these warehouses were no different.

The BBR Contech team utilized the software to assess a frame-long section of the slab in both orthogonal directions, ensuring crack widths and stresses remained within code limitations.

The section was assessed with zero stiffness in the pile supports to negate load transfer to the substructure of the frame. Using assessed ground conditions lower and upper bound pile diameter models were developed to simulate any variances in load spread through the engineered raft.

1 With its new PT ground slab, leading DIY chain PlaceMakers' Dunedin store is now up-and-running.
2 One of the two new 4,000m^2 storage warehouses under construction for Tuapeka Gold Print.
3 BBR Contech installed the post-tensioning for the ground slabs at Tuapeka Gold Print's site using the CONA CMF system with M-type couplers.

2 Branding & expanding: Tuapeka Gold Print

Tuapeka Gold Print is Australasia's largest printer of promotional and branded materials and can print almost any brand or logo onto any product.

They identified the need for two new 4,000m^2 storage warehouses adjacent to their existing premises in the Tuapeka Business Park in Fairfield, Dunedin. The ground at the undeveloped industrial site is understood to contain significant uncontrolled fill thicknesses, comprising overburden soils and weathered rock. Siltstone, mudstone and sandstone are present from moderate depths making a heavily-loaded floor a difficult prospect. A fully piled option was preferred for the site, being the lowest risk approach against likely settlement, given the relatively heavy loads that will be applied.

BBR Contech worked with Thompsons and their consultants as they value-engineered options for the warehouse floor slabs and foundation support. They decided upon a fully-piled solution on a 4.9m x 4.2m grid with 700mm x 700mm pile caps.

The suspended post-tensioned warehouse slab is 330mm thick and designed to carry three tonne rated capacity forklifts and 2,700mm x 900mm back-to-back racking. Each 4,000m^2 x 330mm warehouse is configured as two stop-end slabs each connected at the mid-point with BBR VT CONA CMF M-type couplers which provide an efficient and cost-effective way to increase the slab size and reduce the number of joints.

On both of these projects, leading edge and effective engineered solutions were provided for our clients. Given the scarcity of suitable land for large industrial warehouses in the country's more developed areas, BBR Contech will plan to utilize the same techniques on further such projects in the future.

TEAM & TECHNOLOGY

1 PLACEMAKERS

Owner/client – Calder Stewart Development
Consulting engineer – Engenium Ltd
Main contractor – Calder Stewart Construction
Technology – BBR VT CONA CMF flat
BBR Network Member – BBR Contech (New Zealand)

2 TUAPEKA GOLD PRINT

Owner – Tuapeka Business Park Ltd
Architect – Southern Lakes Design
Structural engineer – Chapman Engineers
Main contractor – Thompson Engineering Ltd
Technology – BBR VT CONA CMF flat
BBR Network Member – BBR Contech (New Zealand)

Gelog II, Villmergen, Switzerland Increased span width & flexibility with CONA CMI

Maximum clear space for production

Flexible accommodation and room for creativity were high on the agenda for the new Richner-Stutz Group headquarters, commissioned by developer Gelog AG in Villmergen, around 30km to the west of Zurich. The team from local BBR Network Member Stahlton AG were on hand to help realize the vision with latest European approved BBR post-tensioning technology.

TEAM & TECHNOLOGY

Client – GELOG AG
Design & build contractor – Xaver Meyer AG
Construction manager – TRIGA Baumanagement AG
Consulting engineer – Wismer + Partner AG
Technology – BBR VT CONA CMI internal
BBR Network Member – Stahlton AG (Switzerland)

On a construction site measuring over 9,000m², the new building – valued at CHF 44 million – offers 136,000m³ of internal capacity. It is divided into a basement with almost 160 underground parking spaces, three production floors, four floors with office and social rooms plus a further production floor.

To achieve this result, a post-tensioned approach to slab construction was adopted. A total of 234 BBR VT CONA CMI internal 0706 post-tensioning tendons allowed the span widths – and thus the support grid in the production and office floors – to be designed flexibly and the slab thicknesses to be reduced to a minimum.

The end result is a structure which has sufficient flexibility built-in to allow for future adaptation and where consumption of construction materials has been reduced – thanks in both cases to the significant benefits of post-tensioned construction. This is another excellent and environmentally-friendly outcome for all stakeholders – achieved with latest, European approved BBR technology.

Overview of the building façade while work was in progress.

Amma Resort, Čanj, Montenegro BBR strand ground anchors

BBR GT solution for luxury resort

A stunning new luxury hotel complex is taking shape on the sunny Adriatic coastline in Čanj, Montenegro and BBR Adria is providing specialist construction services at the very heart of this exciting development.

The 5-star Amma Resort is being constructed for award-winning property developer the Čelebić Group who, in mid-2021, announced a franchise agreement with IHG Hotels & Resorts which will see the opening of the Inter-Continental Resort Amma, Čanj–Montenegro. The resort will offer 198 rooms including 60 suites and a selection of villas, plus wellness facilities, relaxation and fine dining options – alongside on site car parking for 260 vehicles.

The BBR Adria team has executed almost 800 permanent BBR CONA SOL+ strand ground anchors for the scheme. Meanwhile, sister company, BBR Sistemi, carried out the excavation for the entire hotel and apartment complex.

Work on four of the buildings within the resort will be completed by the end of 2023. The whole project is scheduled to be finished during 2025.

TEAM & TECHNOLOGY

Owner – AMMA RESORT d.o.o. Podgorica
Main contractor – ČELEBIĆ d.o.o. Podgorica
Technology – BBR CONA SOL+
BBR Network Member – BBR Adria (Croatia)

Visualization of the completed luxury Amma Resort in Čanj, Montenegro.

University Bridge, Bydgoszcz, Poland Destressing & restressing of stay cables

Stay cable challenge

The work of specialist construction engineering firms, such as those within the BBR Network, often calls for innovation to solve a problem. And sometimes it also involves being part of a wider professional team working on finding a solution for a project that is already familiar. Jacek Sowa tells the story of one such challenge that the team at BBR Polska recently helped to overcome.

The 200m-long University Bridge in Bydgoszcz was built in 2013 as a key structure on the four-lane University Route which stretches 1.58km from north-to-south across the city. Spanning the River Brda, a tributary of the Vistula, the bridge is a composite structure – with a steel frame and a concrete deck.

Unique pylons

The bridge has become famous for the unique shape of its pylons which are almost 70m high and form the shape of two intersecting horseshoes, symbolizing the Greek letters Alpha and Omega. It is at these distinctive pylons that the 16 BBR HiAm CONA stay cables have their upper anchorages. They are arranged in four pairs on each side and encased in HDPE pipe as part of the corrosion protection scheme.

BBR Polska was responsible for installing the stay cables, as well as executing the post-tensioning of the side flyovers and delivery of expansion joints for this landmark bridge.

Recent challenge

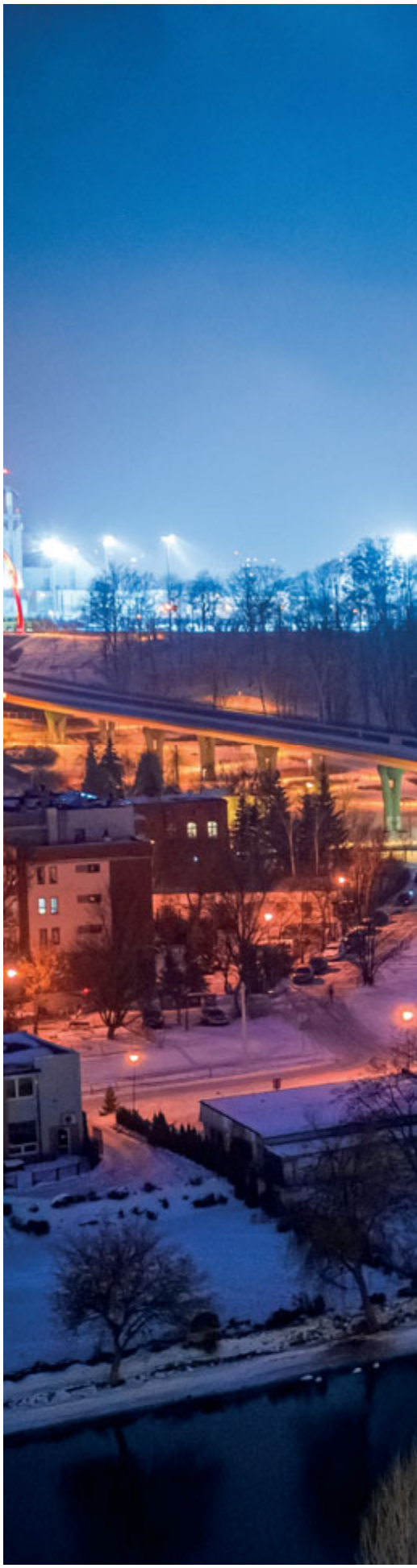
More recently, the bridge has hit the headlines again, but for a very different reason. After just nine years of operation, routine inspections revealed that urgent repairs were needed and the bridge was closed to traffic. The BBR Polska team was called in to provide expertize in destressing some of the stay cables to allow the repairs to be carried out – and restressing them again afterwards.

Structural inspection revealed that there had been a critical deformation of the steel sections where the stay cables have their lower anchorages. The cause of this deformation was diagnosed as being insufficient strength in the steel structure transferring loads from anchorages to the deck and that the solution was to strengthen all 16 of the lower anchorage zones – immediately.

Reducing stress

Having identified the appropriate course of action for repairing the bridge, another challenge then began. In order to effect the strengthening, a method of reducing the force in the stay cables had to be found without requiring them to be completely dismantled and then reinstalled again later. As BBR Polska had installed the stay cables originally, we were first choice for dealing with this challenge.

We worked together with the team at the preparatory stage during which we developed an idea for destressing the strands by 280mm and then restressing them again after the repairs had been carried out. We knew that the idea had to be fast, as simple as possible and – most of all – safe for people. ›



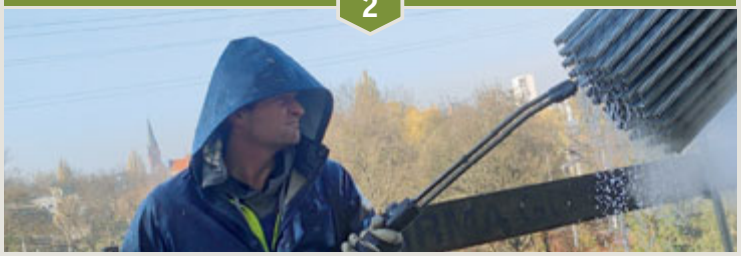
The University Bridge in Bydgoszcz, Poland.

Step-by-Step Guide

1

The destressing process began with the removal of stay cable protection caps using hydraulic equipment and hand tools. Two separate sets of equipment were available to ensure even destressing of one pair of stay cables at a time.

2

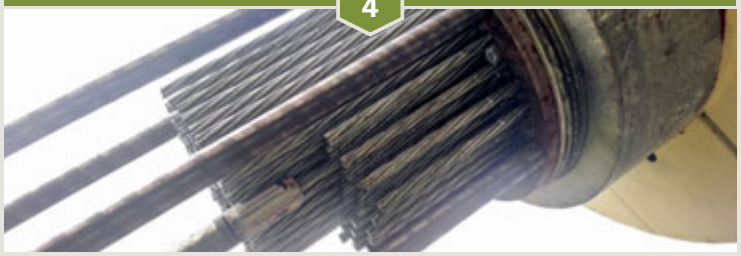


Remaining epoxy resin was removed from the strands and final cleaning carried out using a hot water high pressure washer. This ensured a clean working area and that the couplers we used later would not slip. We prepared six stay cables of sizes from 91 to 109 strands in this way.

3

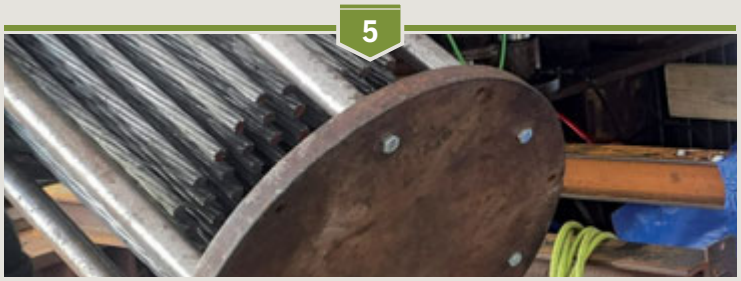
The clean strands are now ready for destressing, seen here with the original force gauge not yet removed. Two opposing stay cables were destressed at the same time to ensure even relaxation of forces in the bridge structure.

4



Individual strands were attached to couplers and a 1m length of strand to facilitate strand-by-strand destressing. In 17 days, the team performed 1,535 individual destressing operations.

5



After bridge strengthening had been completed, the stay cables were restressed, in reverse order to the destressing process. Seen here is a special steel frame installed over each anchorage to assist wedge seating.

Brainstorming & testing

First we contacted BBR HQ for support, as we were keen to access the extensive international experience of the BBR Network for this challenging task. Among other information, Daniel Cuerdo Gómez presented a project executed by Spanish BBR Network Member FCC Construcción where all the stay cables on the Fernando Reig Bridge were destressed, completely removed and replaced (see CONNÆCT 2019 for the full story).

After brainstorming sessions and workshop testing, we chose to deliver the solution using a single strand coupler and special steel frame. The concept was to use a 1m strand with a strand coupler and to destress, strand-by-strand, using a monojack. Workshop testing carried out on a 19-strand test anchorage confirmed that destressing and restressing a stay cable by 280mm would be possible.

Detailed procedure

First we prepared the stay cable strands by taking off the steel protection cap and removing the epoxy resin that had been used to fill the cap. This was difficult, as the epoxy resin was solid and clinging to the strands. We removed some using hand tools and then finally cleaned the whole area using a high pressure hot water sprayer.

In order to keep the pylons and whole structure in balance, a detailed procedure was calculated and planned. So that any structural interference could be minimized, only three pairs of stay cables – with sizes from 91 to 109 strands – were to be destressed and restressed. To do this, a ten step procedure was developed including the following:

- additional ballast on abutment
- lowering of temporary support by 50mm
- destressing of longer pair of stay cables (in two steps – 140+140mm)
- raising next temporary support by 50mm
- destressing of two opposing stay cables (in three steps – 120+90+50mm).

Moreover, work had to be carried out on both stays in each pair at the same time – evenly – and with two separate sets of equipment.

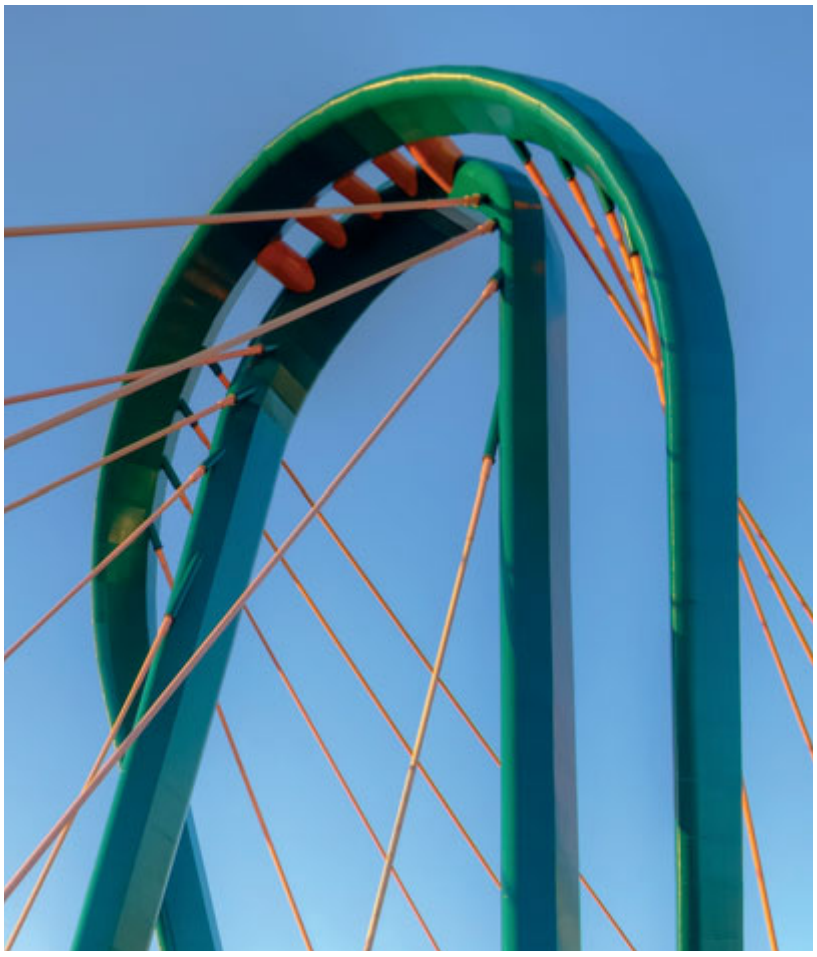
After finishing the destressing operation, the main contractor could start his task of welding additional strengthening steel plates on anchorage zones and ribs inside girders. When this work was completed, we then had to restore the stay cables to their initial force level by executing a stressing procedure, but in the opposite order – that is, starting with the last pair of stays to be destressed. Finally, after all stay cables had been returned to their design stress levels, we filled the protection caps with new corrosion protection gel and reinstalled the caps.

Teamwork & organization

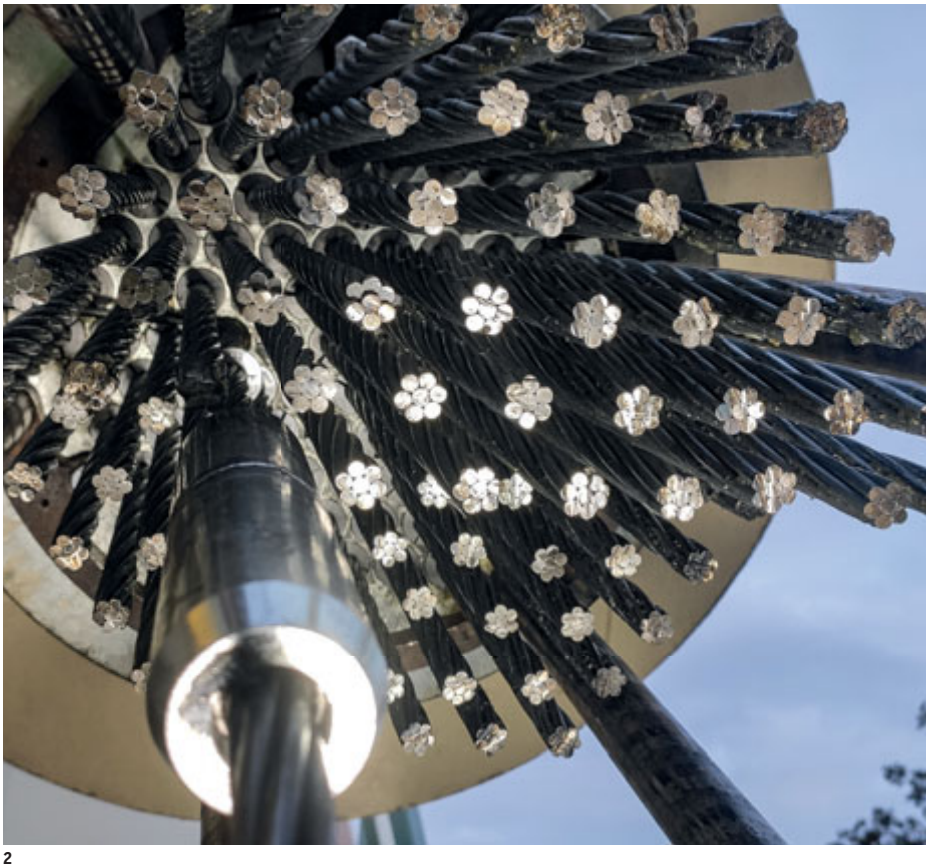
To be certain that everything would be done properly, there was constant presence of and supervision by a skilled BBR Polska engineer. We divided our people into two separate teams working simultaneously. One unintended consequence of this was actually a great advantage – the teams became quite competitive and this really helped to speed up our work.

Preparatory works, such as removing protection caps and cleaning epoxy resin from the strands, could be done before the main work started. The complete destressing process took us 17 working days during which we performed a total of 1,535 individual destressing operations. We had a one month pause while the main contractor performed their works and, on returning to site, our team completed restressing operations in 15 working days.

After work had been completed, measurements of structural deflections and force readings were taken from measuring gauges during load testing carried out by 12 fully-laden trucks. This data fully confirmed the assumptions which were made at the design stage and all parties involved were satisfied that a stronger bridge could now be reopened for traffic.



1



2

1 University Bridge is famous for its uniquely shaped 70m high intersecting pylons at which 16 BBR HiAm CONA stay cables are anchored.

2 Close-up view of one of the stay cables anchorages on University Bridge in Bydgoszcz. It is shown here after removal of the anchorage housing, the 91 strands were destressed one-by-one using a coupler and 1m length of steel strand.

TEAM & TECHNOLOGY

Owner – Local Management of District Roads, Bydgoszcz

Main contractor – Kormost S.A.

Technology – BBR HiAm CONA stay cables, MRR

BBR Network Member – BBR Polska z.o.o. (Poland)

Neville Bonner Bridge, Brisbane, Australia BBR HiAm CONA stay cable system

Forging links for the future

This project has it all – a shining new riverside development location, design by a major international architect and a vision to forge stronger connections between a well-established cultural quarter and an emerging destination which blends repurposed heritage buildings with new features. The BBR Network Member for Australia, SRG Global, is currently working on stay cable installation for the Neville Bonner Bridge in Brisbane.

Designed by renowned architectural practice Grimshaw, this unique 320m long cable-stayed bridge features two 60m long arches from which a walkway is suspended.
SRG Global's first task was to install temporary stay cables to assist the construction of this one-of-a-kind pedestrian bridge. Now, the permanent BBR HiAm CONA stay cable system is being installed. The project will also incorporate BBR Viscous Dampers and cross-ties to stabilize the vibration characteristics of the stay cables in this distinctive structure.
When completed, this new pedestrian bridge will connect the city's South Bank and the new Queens Wharf – and take its place as a distinctive landmark on the Brisbane cityscape.

1

2

The hybrid mast and arch design minimizes the structure required to span the river, creating a lightweight yet dramatic presence through an inherently environmentally responsible solution.

Grimshaw Architects

1 The uniquely shaped bridge superstructure, which had arrived by river, was lifted from a barge and secured into position across the river using temporary stay cables.
2 Looking up from the side of the bridge, via the lower anchorage point, towards the upper anchorage.
3 View of a lower anchorage point beside the bridge deck.

3

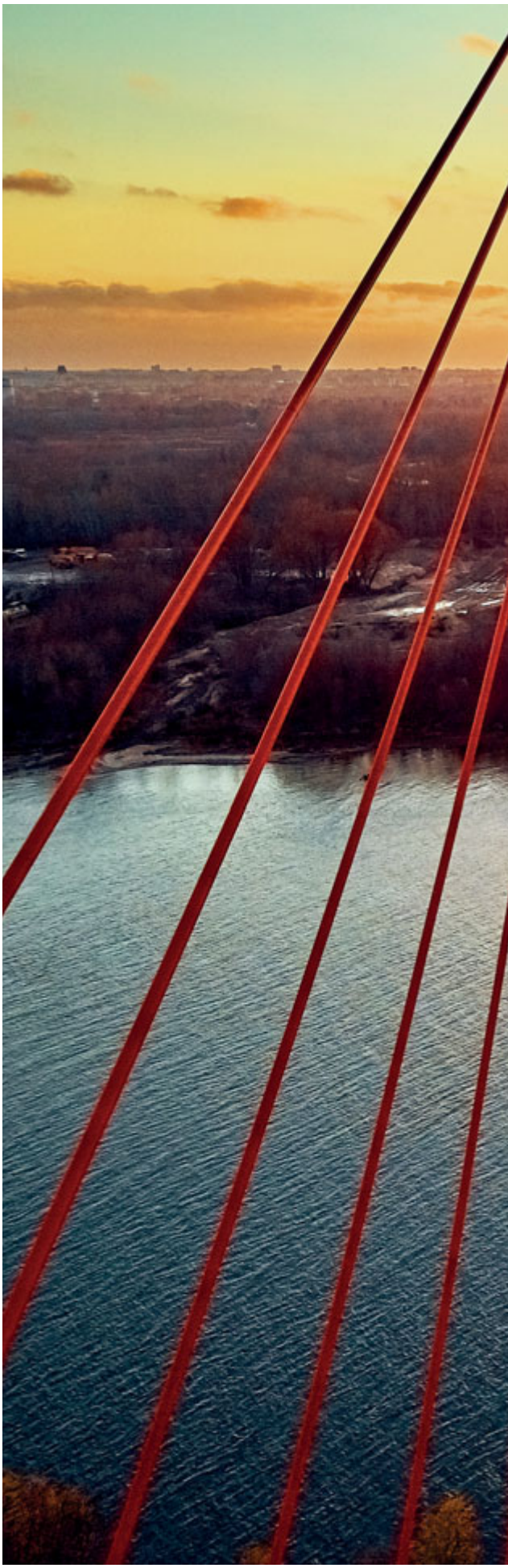
TEAM & TECHNOLOGY

Owner/client – Destination Brisbane Consortium
Architect – Grimshaw Architects
Main contractor – Fitzgerald Constructions Australia Pty Ltd
Technology – BBR HiAm CONA stay cables, BBR Viscous Dampers
BBR Network Member – SRG Global (Australia)

Siekierkowski Bridge, Warsaw, Poland
20th Anniversary of opening

Pushing boundaries in Poland

It was a Saturday afternoon, 21st September 2002. The day was sunny and the sky was clear with just a few clouds. After his short speech, Mr Aleksander Kwaśniewski, the President of the Republic of Poland, cut the ribbon and, with this symbolic gesture, opened the new Siekierkowski Bridge. Tomasz Jendernal of BBR Polska recalls how Siekierkowski became the ninth bridge over the River Vistula in Warsaw – and now celebrates its 20th birthday, along with the huge technical achievement behind this landmark project.



A pioneering project for BBR Polska, Warsaw's Siekierkowski Bridge celebrated its 20th Anniversary in 2022.

Before this high profile bridge-opening ceremony was possible, BBR Polska's engineers and technicians had to do their job – incremental launching of the bridge deck, as well as stay cable supply and installation.

Structural form

The bridge was designed as a twin pylon, cable-stayed structure with a composite deck to carry three lanes of traffic in each direction. It has a main span of 250m and the deck is supported by 56 orange stay cables which allow the bridge to cross the river without the need for any piers in the river bed.

Incremental launching

At 8,570t, the superstructure was the heaviest we had ever launched. It was pulled with two hydraulic hollow-ram jacks with bundles of strands and on specially designed launching bearings. Today we are able to launch much bigger structures – but 20 years ago, this was a real challenge. The main effort, however, was still ahead of us.

Pioneering stay cable technology

Siekierkowski was the second cable-stayed bridge we built in Warsaw alongside this same contractor. It set a record as the first bridge in the whole of Europe to be equipped with the then new BBR CONA Stay cables.

The system had been designed and tested to meet the latest PTI recommendations. It was made up of bundles of 7-wire waxed, galvanized and PE-coated strands which were fixed in anchorages by means of ring wedges. All components – anchorages, HDPE-pipes and strands – were assembled on the construction site. Today, this is standard practice, but Siekierkowski was a pioneer project, where we were developing and implementing the very latest strand-based stay cable technology.

KEY STATISTICS

BRIDGE SPANS
48+77+250+77+48m

SUPERSTRUCTURE WIDTH
33.38m to 40.38m

MAX. WEIGHT DURING LAUNCHING
8,570t

TOTAL NUMBER OF STAYS
56

LENGTH OF STAYS
54m to 131m

NUMBER OF STRANDS PER STAY
43 to 76

STRAND TONNAGE
400t

1

2

Many congratulations and thanks to Jan Piekarski and the team – also the BBR team in Zurich – for having launched BBR Polska and, with all the talent hired and trained over the years, realized such wonderful bridges like Siekierkowski – and many other extraordinary structures in Poland too. BBR Polska – a great success story!

Bruno Valsangiacomo
Co-Chairman, BBR VT International Ltd

3

Connecting people & places

After 20 years in service, Siekierkowski Bridge is a familiar landmark of southern Warsaw. Not only has it brought relief to the road traffic of southern Warsaw, while connecting Gocław and Siekierki, but it has also become an important part of the major east-west road corridor, the DK2 National Road. More than 200,000 vehicles pass over the crossing every day. Cycleways and sidewalks serve those who want to move between green areas on both riverbanks, but at the same time also offer opportunities to take a break and enjoy the view of Warsaw's skyscrapers and the Queen of Polish Rivers – the Vistula.

Our very special thanks go to main contractor Mostostal Warszawa S.A. for trusting us 20 years ago. We are looking forward to continuing this long-term cooperation on our newest project together – the Rzeszów Południe to Babica section of the S19 Expressway. There will undoubtedly be more about this major project in a future edition of CONNÆCT!

4

1 Completion of installation work at one of the lower stay cable anchorages on the bridge deck.
2 Work in progress at one of the upper stay cable anchorage points – note the distinctive orange stay pipes – which were located on the pylons.
3 The first four BBR CONA stay cables are in place. In total, 56 stay cables were installed for the bridge.
4 At the opening of this landmark bridge, journalists (of all ages) were interested in hearing what BBR Polska's then CEO Jan Piekarski (center) had to say.

TEAM & TECHNOLOGY

Client – Miasto Stołeczne Warszawa
Designer – Transprojekt Gdański Sp. z o.o.
Main contractor – Mostostal Warszawa S.A.
Technology – BBR CONA Stay, incremental launching
BBR Network Member – BBR Polska z.o.o. (Poland)

A1 Überdeckung Rosenberg Ost (ÜRO),
St. Gallen & Pont de Recolaine, Viques, Switzerland
Installation of CONA CMI Electrically Isolated Tendons (EIT)

Highest possible corrosion protection

Designated PL3 or Category C, post-tensioning with electrically isolated tendons (EIT) offers maximum protection against water ingress and thus corrosion to structures. Within the BBR range, the CONA CMI internal and CONA CME external systems offer EIT options, all of which are tested and approved to European standards and bear the CE mark. Recently, Swiss BBR Network Member Stahlton has carried out a further two projects involving EIT technology.

1 Roofing over A1 @ Rosenberg East

One of these projects was the covering of the A1 motorway on the eastern approach to the Rosenberg Tunnel near St Gallen. The purpose was to make space for construction of a new events and exhibition hall, along with further associated infrastructure of the OLMA Messen complex. At the same time, a second project was also underway on the site – to undertake necessary restoration work on the Rosenberg Tunnel. In order to tension the prestressed concrete beams in advance, the Stahlton engineers worked on the premises of the manufacturer, FBW Fertigbau Wochner, in Schömberg. Category C (electrically isolated) BBR VT CONA CMI internal tendons were used. Between 15 and 31 strands were pushed into the preinstalled ducts and secured at the appropriately sized anchors, the tendons were then stressed and finally injected with grout.

The individual beams were delivered to the construction site in St. Gallen and, during a series of night time closures of the motorway, they were lifted into their final positions on the existing concrete walls. Additional PT strands were inserted into the ducts at the construction site to connect two or three beams together. ›

View of work in progress for the extended roof section of the Rosenberg Tunnel which uses prestressed concrete beams incorporating CONA CMI Electrically Isolated Tendons (EIT).

Maximum durability with CONA CMI EIT

A 180m long roof over the Rosenberg Tunnel was needed to form part of the base for the new Hall 1 of the Olma Messen exhibition complex. Image courtesy of Olma Messen.

PT IN NUMBERS

201
PT TENDONS

6
TENDON SIZES

5,550m
PLASTIC DUCT

133.5t
PRESTRESSING STEEL STRAND

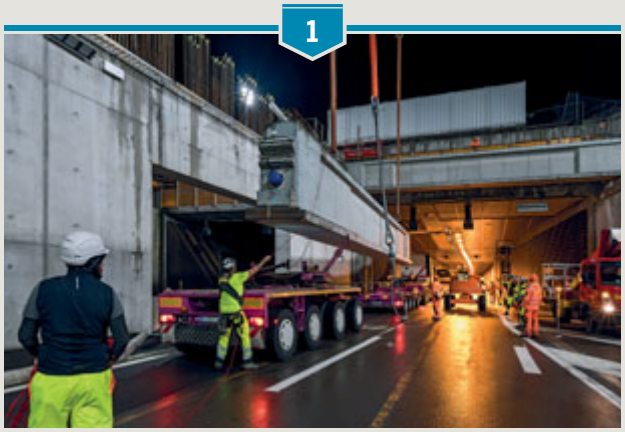
78t
CEMENTITIOUS GROUT

4
MONITORING BOXES

1,000m
MONITORING SYSTEM CABLE

Step-by-Step Guide

1



The prestressed concrete beams were delivered to site by road, during a series of night-time closures of the Rosenberg Tunnel. The team constantly worked against the clock each night to ensure that the road could open again on schedule for daytime traffic.

2

In a carefully planned sequence, each of the 65t beams was delivered to site and lifted into place with the help of a 1,300t crawler crane – the largest in the country.

3

The lifting procedure was repeated for 22 nights until all 186 prestressed beams – and a further 434 roof elements – had been raised and positioned. By the end of the operation, a total weight of 11,700t had been lifted.

4

Each beam was placed with precision and further steel strands were pushed into the preformed ducts to complete the electrically isolated CONA CMI post-tensioning installation.

Photographs courtesy of Michael Huwiler, www.foto-huwi.ch.

The new Recolaine Bridge features CONA CMI EIT post-tensioning which offers the highest corrosion protection level for maximum durability.

2 Recolaine Bridge replacement

Electrically isolated tendons were again chosen for the post-tensioning of the new Recolaine cantonal road bridge over the Scheulte river in Vicques. It was no longer possible to repair and strengthen the existing bridge, so plans were drawn up to replace the structure.

The new bridge was set higher over the waterway and featured post-tensioning with the highest corrosion protection level for maximum durability. Accordingly, the CONA CMI EIT system was chosen. The Stahlton team installed seven 12-strand PT tendons – with a total length of around 130m – and secured these using 14 movable anchorages.

Both of these structures have also been fitted with monitoring systems which will allow health checks to be performed and provide alerts should any maintenance be required. The water-tightness and thus longevity and efficient performance of the structures is thereby assured. Over coming years, it is expected that electrically isolated tendons will be specified more widely to protect our infrastructure as the world grapples with the massive environmental pressures to preserve existing structures where possible and to use our resources wisely in order to reduce carbon emissions.

TEAM & TECHNOLOGY

1 ROOFING OVER A1 @ ROSENBERG EAST

Client – Olma Messen
Engineer – Walt Galmerini AG
Precast concrete manufacturer – FBW Fertigbau Wochner GmbH & Co. KG
Technology – BBR VT CONA CMI internal
BBR Network Member – Stahlton AG (Switzerland)

2 RECOLAINE BRIDGE

Client – République et Canton du Jura – Service des Infrastructures
Engineer – Buchs & Plumey SA
Main contractor – G. Comte SA
Technology – BBR VT CONA CMI internal
BBR Network Member – Stahlton AG (Switzerland)

Accredited accessories for EIT

Electrically isolated tendons are installed on construction schemes to protect the post-tensioning system from water ingress and thus corrosion. These are the ultimate and most protected PT solution (up to PL3) on the market today. The BBR VT CONA CMI and CONA CME systems have both been tested and ETA approved. To support these leading edge solutions, BBR also offers a range of couplers and ducts which have also been tested to latest technical standards and bear the CE mark.

Precast segmental coupler

- successfully tested following the stringent requirements of *fib* Bulletin 75, included in the latest ETA
- corrosion protection level up to PL3 (including PL2)
- sizes up to 130 mm.

H & K couplers

- EIT solutions for both CONA CMI and CONA CME H and K coupler are included in the latest ETA.

Plastic duct

- BBR range of plastic ducts now features more size options – up to 160mm for round duct and up to 79mm x 111mm for flat duct
- initial type testing up to PL3 (including PL2) and full conformity following *fib* Bulletin 75 in terms of Factory Production Control (FPC) and Auditing
- initial type testing of leak tightness up to PL3 on different sizes following stringent requirements of *fib* Bulletin 75.

For more detailed information, why not download the BBR VT Plastic Duct & Accessories brochure from the BBR Network website – www.bbrnetwork.com

Pres-Lam Buildings, New Zealand Installation of PT bars

Sitting lightly on the land

Today, construction with Pres-Lam – prestressed laminated timber – has become a popular method for its environmental, sustainability, cost, design, weight and performance advantages – as well as its resistance to earthquakes. Peter Higgins, Southern Regional Manager of BBR Contech provides an insight into the technique's evolution and into three recent projects.

Through our earlier support of research in providing post-tensioning services at the University of Canterbury, BBR Contech was there at the very birth of Pres-Lam techniques. In the University's labs, we assisted with the evolution of post-tensioned timber buildings and components using techniques developed by Professors Andy Buchanan and Stefano Pampanin.

The first prototype Pres-Lam building was constructed on campus in 2011. Since then – and particularly following the Christchurch earthquakes – there has been a heightened interest in the technique which reduces earthquake damage by dissipating energy and controlling movement in the structure. A rapid succession of new build structures have been rolled out using this post-tensioned timber approach – and BBR Contech has become the pioneering construction technology partner in this segment.

1 Ashburton Library & Civic Centre

The three-storey, NZ$57 million Ashburton Library and Civic Centre caters for a range of services. As well as the 2,450m² library, it includes the Council chambers, a civil defense emergency operations center and an information center – and has also given a new lease on life to the 107-year-old Pioneer Hall, which sits in the middle of the structure and can be seen from all sides.

We supplied, installed and stressed the 218 bar tendons required to secure the building's 46 lightweight, seismic-damage-resistant cross-laminated timber (CLT) shear walls. The work also included installing eight stainless steel cables supporting laminated-veneer-lumber (LVL) beams, two pairs of stainless steel braces in the Pioneer Hall and three stainless steel tendons for the building canopy.

1

2 Auckland University of Technology (AUT)

This project – for the North Campus – will provide a new four-storey, 10,000m² building that connects, via a timber-framed atrium, to an existing one.

Importantly, the building will build on and reflect AUT's commitment to energy efficiency, by delivering on its 2030 net-zero targets for operational and embodied carbon and setting an industry standard for energy-efficient consumption in Australasia.

One of the keys to this achievement will be its use of Pres-Lam and its adaptive reuse of an existing building. As the lightweight timber structure will reduce the new building's weight, so too will there be reductions in carbon emissions and the amount of concrete required in the foundations. Adding to this, many of the building components will be both recyclable and easily dismantled for re-use, and the sawtooth façade and other features will ensure a pleasant – and low environmental impact – workplace.

Here, our role is to supply and install the post-tensioned bars to the Pres-Lam beams for the building's four levels. The beams are assembled into frames while sitting flat on the ground, and two 25mm PT bars are installed along each beam line. With nine frames to be assembled this involves a total of 72 tendons, each about 22.5m long. The frames are then stressed and lifted into place by crane and tied to the floor slab.

3 AgResearch Lincoln Campus

The new, two-storey, 7,600m² AgResearch facility has been designed to accommodate 290 staff and comprises two structures. The laboratory building requires a heavy mass concrete structural system, while a workplace building with a lightweight timber structure reflects and responds to the client's wish for a low carbon footprint and the use of locally sourced materials.

Here, we have installed 76 bar tendons vertically through 14 CLT shear walls. The team began at the top of the structure and coupled them to starter bars cast into the foundations, then used a jack at the top to stress them to the nominated loads. This work will ensure that, in an earthquake, the panels will rock and the bars will eventually return to their original positions. What's more, the smart design allows direct access to the structure at any time, so tendon loads can be checked, issues identified and fittings replaced quickly and easily.

On all three recent projects, BBR Contech has been delighted to work alongside the same main contractor and structural designer – Naylor Love and Beca, respectively.

It's been great for teamwork and also project productivity. We look forward to our next opportunity to deliver some more excellent results together.

1 Ashburton Library & Civic Centre – under construction using the Pres-Lam system, the new building will preserve a heritage structure while serving community needs and resisting the effects of seismic activity.
2 Auckland University of Technology – the building will build on and reflect AUT's commitment to energy efficiency.
3 AgResearch Lincoln Campus – the Pres-Lam approach will ensure that, in an earthquake, the panels will rock and the PT bars will eventually return the building to its original position.

TEAM & TECHNOLOGY

1 ASHBURTON LIBRARY & CIVIC CENTRE
Owner – Ashburton District Council
Architect – Athfield Architects
Structural designer – Beca
Main contractor – Naylor Love Canterbury
Technology – PT bars
BBR Network Member – BBR Contech (New Zealand)

2 AUCKLAND UNIVERSITY OF TECHNOLOGY
Owner – Auckland University of Technology
Architect – Jasmax Architects
Structural designer – Beca
Main contractor – Naylor Love Auckland
Technology – PT bars
BBR Network Member – BBR Contech (New Zealand)

3 AGRESEARCH
Owner – AgResearch Ltd
Architect – Architectus
Structural designer – Beca
Main contractor – Naylor Love Canterbury
Technology – PT bars
BBR Network Member – BBR Contech (New Zealand)


2


3

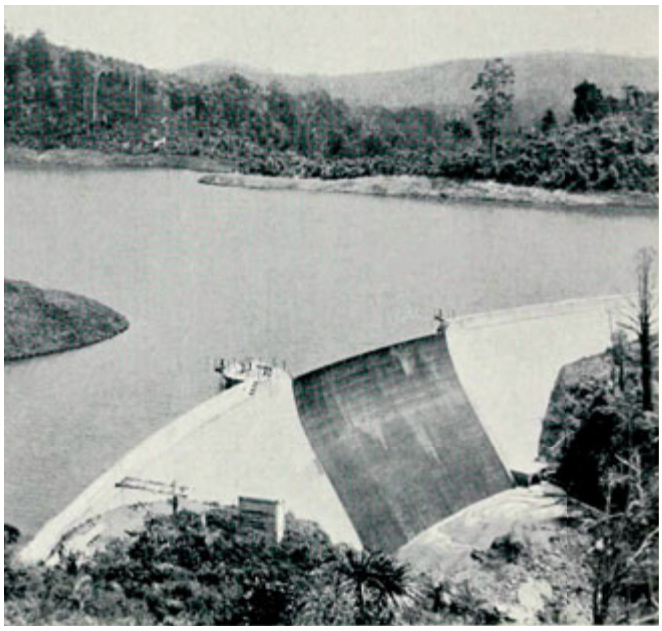
Waitakere Dam, New Zealand Inspection of rock anchors

Testing of dam anchors

Every five years, New Zealand's BBR Contech is tasked with a specific duty – to send a team to the Waitakere Dam near the city of Auckland and conduct 'lift-off' tests on the dam's anchors, which were installed in the 1990s. The dam stores a large amount of Auckland's drinking water.

The job dates back to the 1990s, when dams around the world – built decades earlier and often structurally altered since originally constructed – were found to fall short of modern safety standards, particularly in their ability to withstand natural disasters such as earthquakes.

The Waitakere Dam was a prime example. Built between 1907 and 1910 as a curved concrete gravity dam, the crest had been raised in 1926-1928 from a height of 19.51m to 25.3m to double its capacity. Although it had given more than 60 years of trouble-free service, an analysis of its condition revealed that, of all Auckland's 10 water-supply dams, it presented the highest hazard risk – including risk to the people living downstream.



1

2

3

4

Engineering solution

In response to this report, in 1991 BBR Contech was awarded the anchoring contract to increase the dam's stability under extreme earthquake load conditions. The solution was to install 55 vertical BBR CONA 7,420kN post-tensioned rock anchors (30-60m long) that were double corrosion protected and could be restressed at any time throughout the structure's lifespan. In addition, the company installed 260 BBRV post-tensioning tendons to stress together the sections of the original dam and the dam built in the late 1920s. Two horizontal BBRV tendons were provided for each vertical rock anchor to resist bursting stresses.

Regular inspection

Recognizing the importance of the post-tensioned anchors, they are inspected every five years to ensure they're holding firm. As the strands are greased and sheathed in the free length, the tension can be checked with a lift-off test.

In May 2022, the BBR Contech team returned to the site to inspect the physical condition of the anchored structure, the anchors themselves (for corrosion, distortion, damage, water ingress, contamination, thread condition etc) and the anchorage zone above and below the bearing plate.

Portable innovation

The anchor testing was facilitated by a custom-designed 500T lift-off jack that can be transported and positioned to check anchor loads and restress anchor tendons if any minor losses are noted.

Excellent performance

The dam is in tip-top condition, a great testament to BBR Contech's 1991 work. The team found the anchors' performance and condition to be excellent – almost as good as the day they were installed. Of course the team will be back in 2027 to check that they continue to perform as intended.

1 Waitakere Dam and reservoir before the top of the dam was raised in 1926-28. Source: Internet Archive Book Images, No restrictions, via Wikimedia Commons.
2 The dam and reservoir in the early 1990s when BBR Contech installed 55 vertical BBR CONA 7,420kN post-tensioned rock anchors and 260 BBRV post-tensioning tendons to stress together the sections of the original dam and the dam built in 1927.
3 Almost 100 years since the construction of Waitakere Dam and reservoir, the surrounding landscape has been reclaimed by natural vegetation.
4 The BBR Contech team literally lifted the anchor heads to inspect the BBR anchors at Waitakere Dam. They used a purpose-built lift-off jack to check anchor loads and restress tendons if any minor losses were noted. The dam anchors were found to be in excellent condition.

TEAM & TECHNOLOGY

Client – Watercare Services Ltd
Main contractor – BBR Contech
Technology – BBR CONA rock anchors, BBRV post-tensioning
BBR Network Member – BBR Contech (New Zealand)

Cement Silo D, Port Melbourne & Water Tank, Karratha, Australia
Techniques for tanks

Tanks for everything!

Every day construction teams including BBR Network Members deliver complex or demanding projects for their customers. They do this because they love using their talents and latest technology to meet even the trickiest challenge. It's all in a day's work for them, however, it is so great when someone takes the time to say thank you or offer congratulations for extra special efforts. Here, we present two standout cases from the past year which both involve Australian BBR Network Member SRG Global and, coincidentally, the construction of tanks – albeit by two very different methods.

1 World record in Melbourne

One of these projects was the construction of Silo D at the Melbourne Cement facility in Port Melbourne, Victoria. It is believed to be one of the world's largest concrete multi cell silo (MCS).

The role of SRG Global in this major scheme was the design, supply and operation of the movable slipform system. The continuous slipforming of the walls required some 100 workers each shift to feed reinforcement and concrete into the structure as the rig climbed over 70m high. This round-the-clock process finally reached its objective in the early hours of the morning. At that point, main contractor Fitzgerald Constructions was moved to post a very appreciative and emotionally-charged social media message thanking the whole team for their efforts and expertise. This great message is reproduced, unedited, in the adjacent panel.

Cement Silo D, Port Melbourne – a complex combination of temporary works was required to provide resources to the top of the slipform continuously.

"Definition of Courage: the ability to do something that frightens many, while exhibiting the mental strength to venture, persevere, and withstand all challenges, no matter the difficulty.

On Monday 19th September 2022 at two in the morning, our privately family owned business, together with 200 members of our construction family, working around the clock, achieved a feat that will be looked upon throughout the world.

Our Silo D achieved its RL target height of 71.5m and with an internal diameter of 34m, became the largest multi compartment cement silo in the world with 45,000 tonnes storage capacity, exceeding the last one, by 50%.

We had never built a silo before, let alone utilizing a slipform to construct anything, but it did not diminish the courage of our people to learn, plan, commit, engage and come together in the one common interest, to passionately deliver this silo safely, with quality to be proud and in an environmentally responsible manner.

Gratitude to our client Melbourne Cement Facility and its shareholders for having the courage to allow us to transform their vision into an incredible reality.

Gratitude also to the Silo D team suppliers and partners, who joined our committed spirit of fearlessly moving upwards, no matter the winds, rain, hailstones and darkness of those cold nights.

And finally, Gratitude to our team, all 200 of them regardless of whether they were Managers, Supervisors, Engineers, Surveyors, Crane Operators, Concretors, Steel fixers or Laborers, you all became one team, focused on the one objective and you did us all proud.

We thank each and every one of you and we thank your supportive families."

Fitzgerald Constructions Australia Pty Ltd

FAST FACTS – KARRATHA WATER TANK

CAPACITY
20 million liters
potable water

DIAMETER
15.5m

HEIGHT
16.33m

CONCRETE QUANTITY
942m^3
for tank base & panels

WALL PANELS
28
@ 55t each

BUTTRESS PANELS
4
@ 70t each

POUR OF CONCRETE BASE SLAB
48 people
& lasted 17 hours

TEAM
60
contractors & sub-contractors

EXPECTED LIFESPAN OF CONCRETE TANK
100 years

The new 42m diameter water tank in Karratha was designed and constructed of post-tensioned precast concrete panels.

2 Award-winning water tank

Meanwhile, some 4,500km away, on the other side of Australia, another SRG Global team was working on the construction of a new A$15m water tank in Karratha for Water Corporation. The previous steel tank had been damaged beyond repair during Tropical Cyclone Damien in February 2020.

At 42m in diameter, the new tank has durable 15.5m concrete walls and a concrete roof – providing increased resilience during intense storms and cyclones, as well as requiring less maintenance.

Leveraging SRG Global's strength in design and construction of post-tensioned concrete structure, the tank was constructed of precast concrete panels with in situ concrete stitch infills. Once installed, the tank was post-tensioned using 14 radial tendons to provide the strength to support the water pressure during operation. These tendons were a series of 12-strand BBR VT CONA CMI internal tendons anchored into buttress panels. The base slab also featured a series of flat slab post-tensioning to reduce concrete cracking, as well as BBR VT CONA CMI tendons in the ring beam.

A concrete roof was constructed to ensure that the project met the 100 year design life criteria in a cyclone-prone region. Extensive temporary works were required to be able to safely construct the large precast panels given the significant weather events that the area experiences. SRG Global, with its suppliers and partners, developed a temporary frame structure utilizing area-specific resources such as cyclone blocks to provide the support for the panels until the in situ concrete was poured.

SRG Global was main contractor for the project, with over 67% of the project expenditure being with companies in the region including among others, Karratha-based, Aboriginal-owned company Yurra who carried out roadworks.

This time, the accolade came in the form of a 'Judges Award' from the Civil Contractors Federation Western Australia in their Earth Awards scheme. The Judges Award is a discretionary award for a project which scores highly and which the judges consider to be worthy of special recognition.

The judges said: "SRG demonstrated commendable planning, design and execution of the works to build a staged concrete structure with an expected lifespan of 100 years in a region where extreme weather events are prevalent."

Many congratulations to both teams for their excellent results, dedication to customer service and being such great people to work with. For those who have read this far, as we go about our daily lives please let's all remember the power of those two little words – 'thank you'!

TEAM & TECHNOLOGY

1 SILO D
Client – Melbourne Cement Facility
Main contractor – Fitzgerald Constructions
Technology – Slipform Construction
BBR Network Member – SRG Global (Australia)

2 KARRATHA WATER TANK
Client – Water Corporation
Main contractor – SRG Global (Australia)
Technology – BBR VT CONA CMI internal
BBR Network Member – SRG Global (Australia)

Before connecting the two bridge sections, they were aligned longitudinally and transversally using hydraulic jacks.

Railway Rehabilitation, Deva, Romania Heavy lifting & launching of steel bridges

Making tracks in Transylvania

Three steel bridges – weighing up to 5,300t – needed to be placed across the river as part of a railway improvement program in Romania. Javier Rivera Casado from local BBR Network Member FCC Construcción describes how their specialist knowledge and bridge launching expertise were applied to overcome the challenge.

The scheme comprised the rehabilitation of about 43km of railway line between Gurasada and Simeria. It required the construction of 17 bridges and three metal structures over the Mures river. Part of the IV Pan European corridor, the project aims to improve local railway transport and was funded by the EU within the POIM program for the modernization of Railway Corridor IV Curtici-Brasov-Constanta.

Structural bridge form

FCC Construcción was involved in the design and launching of the three steel railway bridges over the river. All three bridges have steel girders and precast slabs, with a typical cross-section of 10m width and 10m height. In their central section over the river, all were continuous bridges consisting of three spans with lengths of 80m+110m+80m, complemented with two or three 50m-long approach spans crossing the river.

Bridge launching hydraulic jacks

Launching was performed by reaction pulling/retaining from the abutments or pile with two bridge launching pulling jacks and two retaining jacks (2,300kN capacity), with seven compact steel strands and using a 300mm stroke. With this set-up, launching speeds of up to six meters per hour were reached.

Launching technique

The launching system was automated, with synchronization between the pulling and retaining jacks, monitoring displacement, the continuous control of pressure, load and movements of the strand jacks and adjusting different speeds during the different launching phases.

The bridge superstructure was supported by a system of temporary sliding bearings and lateral guides that was installed on the permanent piles and abutments. The sliding bearings consisted of temporary supports equipped with monitored hydraulic jacks which allow adjustment of the launching level and check the vertical load. The sliding surfaces were fitted with a pack of reinforced steel laminated elastomeric pads with a Teflon sheet to reduce the friction between bearings and the bridge sections during the launching operations, also a lubricating agent was applied over the pads and the steel section achieving friction between 2-5%.

The bridges were launched in two stages, one from each side of the river, using a 20m steel launching nose for the longest 80m spans. After finishing the launching process and before connecting the two sections of each bridge, both sections were aligned – longitudinally and transversally – using hydraulic jacks. Subsequently, the bridges were lowered, with the load being transferred onto the permanent bearings and fixing elements.

TEAM & TECHNOLOGY

Client – CFR – Compania Nationala De Cai Ferate

Main contractor – Joint Venture FCC-Convensa-Astaldi

Technology – Heavy lifting, launching

BBR Network Member – FCC Construcción, (Special techniques department BBR-PTE) (Romania)

RAMA III Bridge, Bangkok, Thailand Heavy lifting with CONA CME

Thailand's widest bridge

Some amazing heavy lifting work is underway for the new 2km-long, 8-lane Rama III bridge over the Chao Phraya River in Bangkok. The deck consists of massive 450t steel slabs which are being raised and positioned by BBR Siam who, as well as designing and supplying the lifting machinery, are now operating the system.

1

The team is using 12 temporary CONA CME 2706 external multistrand post-tensioning tendons for hanging the 450t segments and a 220t segment lifter – making a combined weight of 670t during launching operations.

Some 85 segments will be needed to complete the river crossing. These are being delivered by barge and, after connecting the CONA CME tendons, are lifted using the BBR-designed segment-lifter. The segments are raised at a speed of one meter per minute and the purpose-designed equipment can lift the segments to a maximum height of 55m.

Construction is advancing across the river from the two H-shaped pylons of the bridge and work continues round-the-clock to complete the deck which will form the 450m main span. Due to open later this year, the new bridge is under construction adjacent to the Rama IX bridge and is a key component of the Expressway project which will facilitate travel between Bangkok and the west.

1 The Rama III bridge is under construction with the help of specialist heavy lifting techniques and technologies from BBR Siam.
2 Bridge beams are being delivered by barge and, after connecting the temporary CONA CME tendons, are lifted using the BBR-designed segment-lifter.

2

TEAM & TECHNOLOGY

Owner – Expressway Authority of Thailand
Designer & Engineer – Epsilon Design Consultancy Ltd
Main contractor – Ch. Karnchang Plc
Technology – BBR VT CONA CME external, heavy lifting
BBR Network Member – Siam BBR Systems Co. Ltd (Thailand)

Hazelmere Dam Strengthening Completion, South Africa
World record ground anchor testing & installation

Multiple world record breaking dam strengthening

In recent years, the height of Hazelmere Dam in Durban, KwaZulu Natal, South Africa was increased to allow the reservoir to hold more water and structural strengthening work was needed to accommodate the resulting loads. Project Engineer Vutshila Mkhatshwa tells the story of how BBR Network Member SRG Global created new world records during their work installing 83 permanent ground anchors and providing associated expert services.

Hazelmere Dam is a concrete gravity arch-type structure which is 478m long with a center line radius of 725m. It incorporates a 103m-long ogee spillway, situated 60m from the right bank end. The dam was originally completed in 1976 and was designed and built to accommodate a proposed increase in dam height.

Initial works

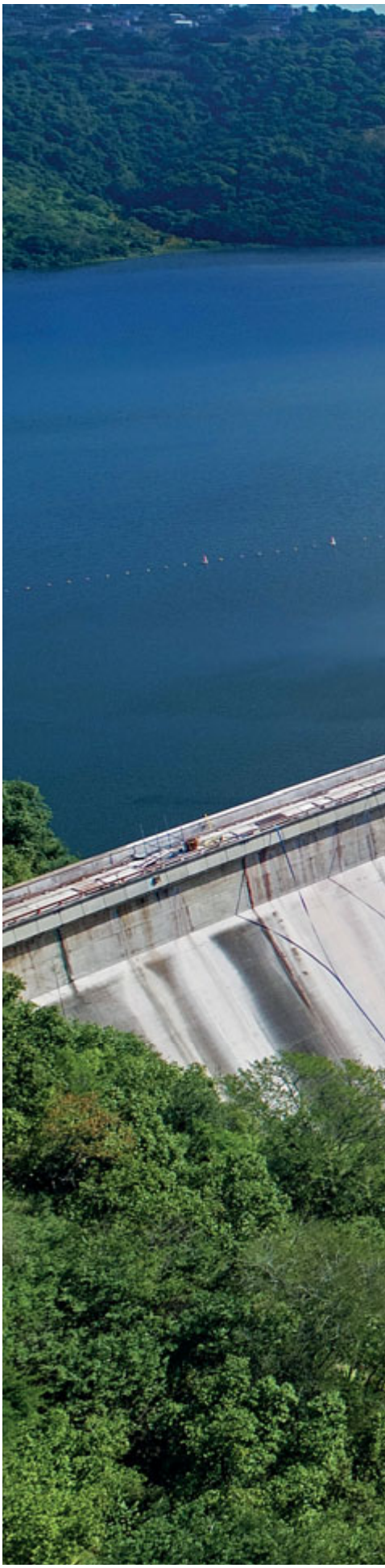
Initial works on the project were undertaken during 2015-2017 which included repair of the grout curtain to reduce leakage under the dam wall, construction of a piano key weir to increase the dam wall height by seven meters and installation of ground anchors to strengthen the wall to accommodate the increased loads generated by the higher water level.

As part of the initial works, the SRG Global team undertook a successful and comprehensive program of in situ ground capacity investigation tests.

The work involved construction of four 61-strand test anchors using 15.7mm diameter strand of low relaxation grade and minimum breaking load (MBL) of 279kN.

The trial anchors were installed at four representative locations across the dam site within 356mm diameter boreholes and comprised free lengths of between 34-36m and bond lengths of 3.0m. These sacrificial test anchors were loaded up to 80% of MBL and achieved a maximum permissible load of 13,615kN using one of SRG Global's 1,500t stressing jacks. At the time, this was understood to be the largest sacrificial test anchor program undertaken – ever, anywhere!

However, in the last few months, SRG has broken its own record with a sacrificial test anchor program at Paradise Dam in Queensland using four 91-strand anchors which achieved a maximum permissible load of up to an astonishing 20,311kN. But this will be a story for a future edition! ›



SRG Global returned to Hazelmere Dam in 2022 for the second phase of strengthening works involving installation of the world's largest ground anchors.

Final anchor design & installation

During the tender period, SRG Global designed an alternative to the originally planned 243 x 25-strand anchor scheme by proposing use of larger anchors of up to 91 strands. This work led to the adopted solution which included only 83 anchors – allowing construction optimizations and significant cost savings for the client. The information gathered from the investigation at Hazelmere Dam determined the final design, anchor size, bond length and configuration for the permanent ground anchor works utilizing 15.7mm (279kN strand). The final design comprised 12 x 91-strand anchors, 31 x 80-strand anchors, 10 x 61-strand anchors and 30 x 49-strand anchors with nominal lengths between 52m and 95m.

The anchors have been designed and detailed to be capable of being monitored, restressable and destressable at the end of their required life. The anchors have been designed for a working life of 100 years. Incorporated as part of all anchors is a heavy wall, full-length, external polyethylene duct. The internal tendon is fixed in grout over the lower bond zone (6m for 49-strand, 7m for 61, 8m for 80 and 9m for 91) with each strand individually greased and sheathed over the remaining free length of up to 86m. All anchorages consist of an externally threaded anchor head sitting upon a galvanized bearing plate.

Nominally, a 300mm length of strand protruded above each anchor head in order to allow for possible future load adjustment. An HDPE grease cap was placed over the protruding strand and the void filled with a flexible corrosion inhibiting compound. Externally, the anchor block was coated with grease and wrapped with tape to protect against corrosion. The whole assembly was then fitted with a galvanized steel protection cap, which was bolted and sealed to the bearing plate.

SRG Global undertook the drilling, drilled hole waterproofing works, anchor fabrication, installation, grouting, testing and corrosion protection with the first stage of permanent works spanning from March 2016 and December 2017. All anchors were completed during this period with the exception of ten anchors which remained unstressed as they were designated to incorporate permanent load cells. The delay in completion of the Hazelmere Dam project was due to the budgetary constraints of the dam owner.

The anchors have been designed and detailed to be capable of being monitored, restressable and destressable at the end of their required life.

1

2

Remobilization

SRG Global re-mobilized at Hazelmere Dam in July 2022 to undertake the balance of the stressing and corrosion protection works for the 10 anchors designed to incorporate 150mm high hydraulic/electronic pressure transducer annular load cells.

Record sized load cells

SRG developed a bespoke design to enable a 100-year corrosion protection system for the 10 anchors which incorporate the permanent load cell components.

Three different sized permanent load cells were used – 10,000kN capacity load cells to suit two 4906 anchors, 13,000kN load cells to suit the two 6106 anchors and 20,000kN capacity load cells to suit six 9106 and 8006 anchors. It is understood that these are the largest permanent anchor load cells ever produced and incorporated within an anchored structure.

World's largest PT jacks

The anchors were stressed using the two largest post-tensioning jacks ever built – suited for 61 and 91 strands of 15,000kN and 22,000kN capacity, both with a 1.0m stroke. They weigh seven tonnes and ten tonnes respectively and, when extended, stand up to 3.8m tall.

Residual load monitoring

In order to measure the residual anchor forces, and part of the Stage 1 scope of works, SRG designed and supplied purpose-built 12,500kN and 16,500kN mobile lift off devices to suit the four sizes of anchor heads that were installed. The anchor heads are of two diameters with the smaller load monitoring equipment suited to 49- and 61-strand anchors (4906 & 6106) and the larger equipment for the 80- and 91-strand anchors (8006 & 9106).

As a five year period had lapsed between the initial works and the 2022 Stage 2 works, SRG were also contracted to undertake residual load monitoring on all 73 anchors that were stressed during the Stage 1 2016-2017 period. The purpose of the load monitoring program was to ascertain each anchor's individual performance by measuring the residual load, enabling determination of any load loss since installation, and verification they are within acceptable criteria.

SRG Global's Stage 2 works for the Hazelmere Dam Project were completed with the 10 remaining anchors stressed by October 2022 and load monitoring operations finished in December 2022. This highly significant milestone means that Hazelmere Dam, with its seven meter increased height of stored water, now meets international dam safety requirements for stability.

1 Overview of SRG's drilling operations and the spillway's piano key weir construction underway.
2 Aerial view of the piano key weir which was built to increase the dam wall height by seven meters.

TEAM & TECHNOLOGY

Owner – Umgeni Water/Department of Water & Sanitation (DWS)
Main contractor – Group Five Constructions Proprietary Limited
Technology – BBR CONA SOL+
BBR Network Member – SRG Global (South Africa)

Viaduc de Bonpas, Vaucluse, France Strengthening, repair & maintenance

Fit for the future

The Viaduc de Bonpas – a major structural element of the A7 Highway near Avignon in southern France – is undergoing a €12 million strengthening, repair and maintenance program to ensure its continued performance long into the future. The work, which is being carried out for operator VINCI Autoroutes by BBR Network Member ÆVIA, will be completed this year. Project Engineer Antoine Dupré takes us on a tour of this massive project.

1

Originally constructed in the late 1960s, this twin carriageway viaduct carries the six lanes of the A7 Highway across the River Durance – the longest river in Provence which flows along the border between the departéments of Vaucluse and Bouches du Rhône. As well as ensuring that traffic is still able to continue using the highway during the works, a colony of bats – a protected species – which has made its home beneath the viaduct must also be undisturbed. In fact, the project is being completed in two stages, with the construction program being organized around the bat breeding season. Work on one carriageway was completed last year and the second phase is currently underway.

Structure & scope

There are two 548m long concrete bridge decks, each of them 15.8m wide. Original construction was of cantilever precast concrete elements positioned on seven pillars, thus making eight spans. The main reinforcement and repair works consist of six elements:

- external post-tensioning
- carbon fiber reinforcement
- pot bearing replacement
- expansion joint replacement
- crack injection
- local concrete repair ›

1 Originally constructed in the late 1960s, the twin carriageway Viaduct de Bonpas carries the six lanes of the A7 Highway across the River Durance, near Avignon, France.
2 View inside the bridge section, where one of the team's biggest challenges was managing the temporary supports which required constant safety monitoring and huge efforts when repositioning.
3 Anchorage of one of the 32 BBR VT CONA CME external monostrand tendons – each consisting of 22 strands of 15.7mm diameter prestressing steel – which are being installed on the project.
4 Stressing of the CONA CME monostrands underway inside the bridge deck.
5 To enable bridge bearing replacement, the bridge deck weighing around 15,000t was raised by 120 lifting jacks.

2

PROJECT IN NUMBERS

2
VIADUCT STRUCTURES

8
SPANS

548m
VIADUCT LENGTH

15.8m
WIDTH EACH CARRIAGEWAY

250t
PRESTRESSING STEEL STRAND

32
BBR VT CONA CME 2206 TENDONS

8,000m
HDPE DUCT

70t
CEMENTITIOUS GROUT

700
PT BARS

64
POT BEARINGS

2
EXPANSION JOINTS

Inside the deck

The external post-tensioning has been carefully sequenced around other works, some of which have been progressing at the same time. A total of 32 BBR VT CONA CME external monostrand tendons – each consisting of 22 strands of 15.7mm diameter prestressing steel – are being installed on the project. Should the need ever arise, these tendons are fully exchangeable, so could be replaced without requiring major construction work.

The new CONA CME external PT tendons are being installed inside the bridge caisson, beneath the highway. Each bridge deck will have eight tendons arranged in two pairs on either side of the deck. All tendons are completely straight as they do not need to pass through a deviator. They are anchored at the right or left bank abutments and at a crossover point above pier 4 (P4 zone).

The P4 zone is a particularly complex and congested area of the caisson and where PT bar quantity optimization was also needed to balance opposing forces from the PT loads in the concrete. In this location alone, some 2.5t of steel reinforcement was required along with four arrays of 15 PT bars each – plus, of course, ducting for the post-tensioning tendons.

Once the anchor blocks had been constructed, we placed the HDPE ducts for the PT tendons. In all, we installed around 8,000m of HDPE ducting. After this, we threaded the monostrands into the ducts using the strand-by-strand method, similar to that used for the installation of stay cables. With this methodology, we achieved a strand insertion rate of one tendon per day. This technique was chosen for logistical and technical reasons – namely, there was insufficient working space for any other method and we did not have a machine powerful enough to thread a 300m length of monostrand.

One of the biggest challenges has been management of the temporary supports. It was a huge task to reposition and to remove the installation. We had to install the support without drilling any holes because the viaduct is full of PT. Any drilling would have required us to scan every zone of the viaduct to be sure we were not drilling into the existing PT. It would have been a very time-consuming job, so we chose to design the supports using a classical scaffolding system. The only problem we have is that the supports move due to the vibration of the highway, so we have to constantly monitor them to ensure they remain in the right place.

Corrosion protection

Next on the program is grouting – and here this operation is of almost legendary proportions. Each 300m long CONA CME tendon requires 3,000l of cementitious grout. To deliver this, we are using a large capacity grout pumping machine. It takes approximately 75 minutes to inject grout into one tendon and, given the high temperatures experienced in the south of France, realistically we plan to grout three or four tendons per day. One feature of the climate in the south of France was that both the water and cement were hot, between 20°C and 30°C. To be able to grout, we used ice to refrigerate the water. Each morning we had a delivery of two tons of ice in order to lower the temperature of the water to between 5 and 10°C. We expect to have injected a total of 70t of cementitious grout into the tendons by the end of the project.

The grout itself must be of high quality and the tendons filled correctly in order to provide the right level of corrosion protection. Meanwhile, these tendons will effectively benefit from 4+ layers of corrosion protection. The CONA CME monostrands have two layers of factory-provided corrosion protection – plastic sheathing and wax/grease. In addition, the plastic duct, grout and finally the concrete cover in the anchorage zone constitute further layers of corrosion protection.

After grouting, the team faced the daunting task of stressing all the tendons which now weighed in at 52kg/m – including duct, strands and grout.

Stressing & completion

Tendon stressing is being carried out with the help of a monostrand jack. It is a tedious task since the monostrands are so long (300m) and produce an elongation of two meters which means we have to do around 10 strokes per tendon to stress it. Each tendon requires one day – and one jack – to achieve its design force. Tendons are stressed in pairs, one in each deck, so as to not create any disparity in force in the structure. Additionally, the anchor block P4 anchors four tendons, two in each direction. These are stressed alternately, meaning one in each direction so as to not overstress one side of the anchor block. After this, finishing works involve the cutting of excess strand, installation of the protection caps and installation of the system anchoring the PT ducts to the concrete every 20m to avoid any vibration. ›

Should the need ever arise, these tendons are fully exchangeable, so could be replaced without requiring major construction work.

3

4

CFRP reinforcement

Beneath the anchorage zones, CFRP strips and sheets were installed on the exterior surface of the viaduct to provide additional strengthening support. Working from hydraulic platforms, the team applied 270m of strips and 650m of sheets. CFRP was used around the anchor blocks for two purposes – reinforcing the concrete for the stressing operations and for the concrete pour as it was too much weight for the existing structure.

Structural accessories

At the same time as the anchor block concreting was being carried out under a six week traffic contraflow on the bridge deck, bearing replacement was also undertaken. The deck was raised one pier at a time with jacks of capacity between 160 and 200t. The total weight of one carriageway is approximately 15,000t and 120 lifting jacks were needed to raise the viaduct The new bearings are of three different types – fixed, guided and free – and have capacities of 2,000kN to 8,000kN. In addition, a new steel expansion joint which can accommodate a 55cm movement was also installed in the bridge deck.

With our work on one carriageway completed, we began work on the second carriageway in September and will complete final stressing of the PT tendons in late spring, in good time to return our site once again to its local inhabitants. At this point, we will be able to reflect with great pride and satisfaction that, through a technically advanced and timely intervention, the continued performance of another piece of vital infrastructure has been assured for the future.

TEAM & TECHNOLOGY

Client – VINCI Autoroutes
Project manager – Ingerop
Technology – BBR VT CONA CME monostrand, heavy lifting, MRR range
BBR Network Member – ÆVIA Câbles et Manutention (France)

5

1

2

Atelier La Vie, North Jeddah, Saudi Arabia Techniques for repurposing

It's a wrap!

An expression borrowed from the film industry seems appropriate to describe one of BBR Saudi Arabia's latest building repurposing projects! The team has not only helped their property developer client convert a retail center into a five-screen cinema, but also to incorporate a gym complete with rooftop swimming pool into another part of the same development. Managing Director Abdulrahman ElFateh and Project Manager Oukba El Assaad describes how they used external post-tensioning and carbon fiber reinforced polymer (CRFP) to strengthen the structure and deliver a great solution.

Atelier La Vie is set to become a new and unique entertainment and leisure destination in the heart of North Jeddah at Al Shattee, close to the Red Sea. Originally built in 2014, the existing commercial development is undergoing a major transformation – being driven by Al Anwa Holding Company for Investment – to create brand new facilities which will make the location into a pedestrian-friendly focal point within the community.

VIP viewing

The aim for one of our projects was to deliver 6,500m^2 of space including a five screen VIP cinema. Our challenge as a specialist contractor was to strengthen the old building which was unable to take the new loads and create the open column-free spaces needed to ensure a quality cinema-viewing experience.

Structural changes included the removal of the existing mezzanine floor and the removal of eight columns, as well as strengthening of the foundations. Over a period of just 10 weeks, we installed external PT using BBR VT CONA CMX systems to support the floor at roof level. We also used 3,000m of CFRP to provide additional strengthening to existing floor slabs and double-wrapped columns with CFRP too. Both of the latter CFRP installations were then protected with a fire-resistant cementitious coating.

Gym facilities

Elsewhere on the same site, a ladies gym needed to be created. This involved a total space of 3,000m^2 over three floors. Here, there were special requirements – for example, floor loadings needed to be increased to accommodate an equipment hall plus a rooftop swimming pool, along with new structural steel floors and staircases. We carried out a full structural assessment of the building and then redesigned the structural elements based on the anticipated load requirements.

Again, we used external post-tensioning from the CONA CMX range for the first floor and roof level floor slabs, plus 1,500m of CFRP to increase the load-bearing capacity of the structure. After a program of only six weeks, the building was ready for fitting out.

The whole BBR Saudi Arabia team really enjoyed delivering solutions for these two projects. It's so great to be able to breathe new life into structures – and we look forward to our next challenge!

1 Visualization of the cinema frontage within the Atelier La Vie development. The location is set to become a unique leisure and entertainment destination in North Jeddah.
2 The façade of the newly renovated and strengthened ladies gym.

TEAM & TECHNOLOGY

Client – Al Anwa Holding Company for Investment
Technology – BBR VT CONA CMX, MRR range
BBR Network Member – BBR Saudi Arabia

Retail Mall, Newtown, New Zealand Seismic strengthening

Rooftop record

It may have been a relatively small job for New Zealand's BBR Contech team, but it was big news for shoppers in Newtown, a small, 2.55km^2 suburb to the south of Wellington, the country's capital city.

A local retail and supermarket mall – located at the southern end of town and just a few minutes' walk from Wellington Zoo – was to undergo a major revamp that would transform its dated structure and provide a state-of-the-art supermarket along with a new shopping and dining experience. What's more, mall owner and long-time BBR Contech client Foodstuffs would be making the building stronger and safer through a comprehensive seismic-strengthening program.

1

2

3

1 The comprehensive strengthening program for a retail mall car park required the application of 4,400m² of carbon fiber strengthening – one of the largest such projects ever undertaken in New Zealand.
2 The work was carried out in three phases to enable the car park to remain open for customers during the work.
3 The floor slabs were finished with a crack bridging coating system especially designed for car park top-decks.

Large scale FRP project

BBR Contech's role was to be the icing on the cake – almost literally! The team would be responsible for strengthening all 2,700m² of a precast-concrete, single-level car park on top of the building, using fiber-reinforced polymer (FRP) as the strengthening material.

The scale of this task placed the scheme among the largest FRP projects ever to be undertaken by the BBR Contech team. Ordinarily, a project like this would be relatively straightforward, but this one came with a couple of challenges

The supermarket was to stay operational through the project, so the car park and the ramp leading to it would have to stay open too; and the work would have a significant impact on the surrounding community, which comprises small businesses and private homes – and owners who would not only have their daily lives interrupted but have to tolerate some considerable noise too.

Local insight

This close connection between domesticity and the machinery of commerce reflects Newton's history as among the first places in New Zealand to be settled by Europeans.

They arrived in the 1840s, drawn by the flat land, and within a decade had established a flourishing community that included Wellington Hospital and the Zoo – as well as the home of Wellington rugby.

After World War II, the suburb attracted a large population of Māori migrating from rural areas, followed in the 1960s by Pacific Island migrants and, later, a period of significant gentrification. Today Newtown, with its population of 9,000 (and growing), is known as a close-knit, hip multicultural community of students and young professionals and is famous for the annual Newtown Festival which over the past 20 years has become New Zealand's largest free music festival and street fair.

Strengthening approach

BBR Contech's role was to start from scratch by preparing the car park surface to withstand the impact of earthquake forces. This meant first removing the existing asphalt and waterproofing membrane and exposing the concrete slab beneath – a noisy process that required extensive communication with the neighbors and wide-ranging research to find the best possible solution.

The next step was to apply a total of 4,400m² of carbon fiber strengthening to the slab's surface and finish with a crack bridging coating system (especially designed for car park top-decks) – and in three stages, given that the car park had to be operational throughout.

Despite some early teething issues overcoming the impact of the noise on shoppers below, the project went smoothly with the team delivering a stronger flooring system that will protect the retail customers beneath.

TEAM & TECHNOLOGY

Client – Foodstuffs North Island
Structural engineer – EQStruc
Main contractor – Legacy Construction
Technology – MRR range
BBR Network Member – BBR Contech (New Zealand)

University of Auckland, New Zealand Strengthening for adaptive reuse

Highest-ever award for sustainability

An 'adaptive reuse' project currently underway at New Zealand's University of Auckland has been awarded 93 points by the New Zealand Green Building Council (NZGBC), achieving a 6 Green Star Design rating. This is the highest score awarded since the inception of the scheme and is thus the country's highest possible rating for sustainability. BBR Contech is delighted to have contributed to this success – undertaking what has turned out to be one of the biggest FRP (fiber-reinforced-polymer) strengthening projects that the company has ever delivered.

The project, which is due for full occupation in 2024, has two connected parts – the refurbishment of the university's 45-year-old School of Social Sciences building that will house the Faculty of Education and Social Work and the Faculty of the Arts; and the addition of a spectacular new timber atrium. Both buildings have been designed to meet the highest standards of health, comfort and function for students and staff, for at least the next 50 years.

Net zero carbon

The concrete façade on the School of Social Sciences building will be replaced with a new, lightweight, super-insulated and airtight system. The decrease in façade weight will enable the addition of an extra floor and be structurally resistant to earthquakes. The building, designed in a collaboration between the University of Auckland, Jasmax and Beca, will incorporate industry-leading 'passive house' design principles, be made of New Zealand extruded aluminum (containing 85% recycled content) and contribute to meeting the University of Auckland's 2030 operational energy targets for net-zero carbon.

Inside the building, high performance solar glazing will reduce glare, while students and teachers will benefit from more comfortable lighting, cleaner air via the application of low-emission paints and coatings, plus a 50% improvement in ventilation rates owing to the use of electric heating, ventilation and air-conditioning systems.

The design is also a water saver, with a predicted 75% reduction in usage compared with a standard comparable building. The water will be collected by a rainwater harvesting system and more than 10% of the building's renewable energy will be generated on site.

1

2

3

What's more, at least 80% of the environmental performance will be monitored and reported through built-in electrical and water metering systems.

As a result of this work, there'll be other benefits too. The building process will send less waste to landfill, create less pollution and, once operational, the building will use only a third of the average energy of an equivalent new building.

By the time you get to this paragraph, you'll probably have understood why the New Zealand Green Building Council awarded the Social Sciences building a 6 Green Star Design rating. A 6 Green Star building, it says, "exemplifies world leadership in environmentally sustainable building practices".

Preservation with innovation

BBR Contech was involved early in discussions on the new building's constructability – working with their client Hawkins, designer Beca and university representatives to ensure that the FRP solution would deliver on the design and construction intentions and meet the stringent requirements for strength, seismic resilience, finish and longevity. The company's role would be to apply more than 2,600m^2 of FRP to the building's slabs, walls and beams – helping to ensure that it stayed up and that the impressive rating remained true.

FRP's most important advantages were its light weight and flexibility, as well as its unsurpassed strength, adhesion and durability when compared with traditional materials.

"Sustainability was a huge driver of every aspect of the build program," says Kishan Seger, a Senior Structural Engineer with Beca. "The decision to repurpose the existing building took into account the fact that it was still in good condition for its age. Targeted seismic strengthening allowed for the building to be upgraded to as close as reasonably practicable to current code whilst diverting the primary structural frame from landfill had significant sustainability benefits. FRP offered us all the advantages of light weight, fast application and comparative affordability. Furthermore, due to thin application of FRP, this element could be co-ordinated with the architect's proposed floor coverings. Moreover, our contractors were familiar with and approved of it – that was a big plus."

For BBR Contech, the project involved applying layers of FRP to the existing structure's walls, floors and beams, covering a total area of 1,250m^2 and requiring up to eight people on site at a time. In all, the project absorbed 4,800 man hours, used almost 800 dowel anchors, and required FRP application at more than 60 installation 'zones' across seven levels of the building.

There were challenges along with way – the discovery of asbestos, which led to the need for night shifts, extra precautions and additional preparatory work; the need to maintain vital cleanliness at all times on what was a very busy and crowded workplace; and the challenges of COVID-19 in terms of staff shortages and just getting the job done.

"Despite the challenges, our collaboration with BBR Contech was very productive," says Kishan. "Their work was well managed and any issues were resolved quickly on site. I think we're all going to be very proud of the results."

The project was supported by the New Zealand Government's Covid-19 response fund through the Infrastructure Reference Group.

About GreenStar

Green Star is Australasia's largest voluntary and truly holistic sustainability rating system for buildings, fit-outs and communities. Run in New Zealand by the Green Building Council, it is "dedicated to accelerating the development and adoption of market-based green building practices to improve the built environment". The ratings range from 4 Star (considered best practice) to 6 Star (world leadership).

1 Visualization of the completed new façade of the University of Auckland's School of Social Sciences building which is currently the subject of an 'adaptive reuse' project that has attracted the country's highest-ever award for sustainability.
2 Slab soffit strengthening allows for adjacent large slab penetration.
3 Overhead installation of FRP for slab strengthening.

TEAM & TECHNOLOGY

Owner – University of Auckland
Architect – Jasmax
Structural designer – Beca
Main contractor – Hawkins Ltd
Technology – MRR range
BBR Network Member – BBR Contech (New Zealand)

Simply the best!

Following world record scale testing, the BBR HiAm CONA stay cable system has been proven to be the best anywhere on the international market. This leading edge stay cable technology is the result of BBR's decades of experience in the sector and of the dedication of its R&D engineers. BBR VT International's Head of R&D, Dr. Haifeng Fan reviews recent events and how BBR's continuous commitment to testing and development has resulted in this amazing and unique achievement.

1

2

KEY ADVANTAGES OF BBR HIAM CONA STRAND STAY CABLE SYSTEM

- First in the world fully complying to *fib* Bulletin 89, including bending fatigue tests & tests on large sizes like 91 & 151 strands
- Full size range (001-217) qualified
- Offers full package, including stay cable (classic anchorage & pin connector), saddles (HiEx CONA & HiBox CONA), damping (viscous & square) & fire protection system
- Backed by 60+ years of experience across 430+ projects of different types – including bridges, roofs, towers, etc – globally

The end of April last year saw yet another major benchmark set by BBR stay cable technologies – with the world's first full stay cable system to be independently tested and proven to comply with *fib* Bulletin 89 guidelines. For this recent test, the BBR team installed a massive HiAm CONA stay cable – with 151 strands, each of 15.7mm – in the laboratory test rig.

The tests were a huge success and the successful results mean that the full size range (001 to 217) of the HiAm CONA stay cable system has now been fully tested and qualified according to the new *fib* Bulletin 89 recommendations. BBR HiAm CONA is currently the only system in the world to have these credentials.

It has, so far, been a voyage of over 60 years – which has demanded much investment, dedication and the relentless pursuit of excellence. An overview of key developments is presented below and further information can be found in the special anniversary feature published in CONNÆCT 2020.

The BBR journey

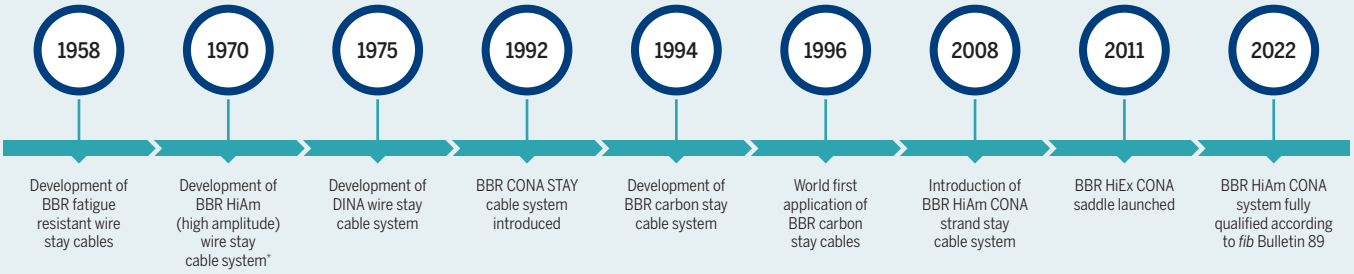
The earliest stay cable technology available to provide the required static strength and high amplitude fatigue resistance was parallel wire cables. The first installation of these modern era stay cables was in 1960, in association with engineering consultancy Leonhardt Andrä & Partner (LAP), for a 100m footbridge – the Ferdinand-Leitner Steg, in Stuttgart, Germany. The 10 BBR wire stay cables consist of bundles of up to 90 parallel 6mm diameter prestressing wires encapsulated in a polyethylene pipe and injected with cement grout. Inspections a few years ago showed that they were still performing well some six decades later.

In the 1960s, stay cables were mostly made of locked coil ropes, but BBR and the LAP team who had worked together on the Stuttgart project, wanted to achieve a higher stiffness and fatigue strength by using parallel wire cables. The result of this technological collaboration was the development of the BBR HiAm (high amplitude) wire stay cable system.

BBR were the first to introduce high amplitude fatigue resistant strand stay cables. These found their first major application in the early 1970s for the new Olympic Stadium in Munich with its cable-supported membrane roof structure which was subjected to high cyclic wind loads. At this point, BBR stay cable technology had begun to travel around the world, with projects on almost every continent. But the BBR R&D did not stop here – technological development continued ceaselessly. Next, in 1975, the BBR engineers developed and launched the DINA stay cable system.

In fact, the 1970s saw over 30 structures around the globe equipped with BBR stay cables – in the decades which followed, this number continued to grow and BBR stay cables were established as the technology of choice around the world. Today, we look back with some great pride on over 430 projects carried out with BBR stay cable technology – but how did BBR reach this position? Read on to discover more! ›

BBR STAY CABLE TIMELINE



*in association with Leonhardt, Andrä & Partner, Stuttgart.

Always one step ahead

Underpinning the realization of these masterpieces is the relentless development of BBR technology which has always been one step ahead of the international recommendations, thus making sure that customers benefit from the very finest and latest technological solutions.

Key international stay cable recommendations to date are:

- PTI DC45.1 (USA), 1st edition 1986, now 7th edition 2018
- Setra (France), 1st edition 2002, superseded by
- *fib* Bulletin, 1st edition 2005 (*fib* 30), now 2nd edition 2019 (*fib* 89)

However, long before the publication of these international recommendations, along with the technology development and world-record projects, BBR had already accumulated a great number of pioneer testing experiences. These were conducted with third party, independent laboratories within well-known institutes such as EMPA (Switzerland), TU Wien (Austria) and CTL (USA).

Landmark early testing

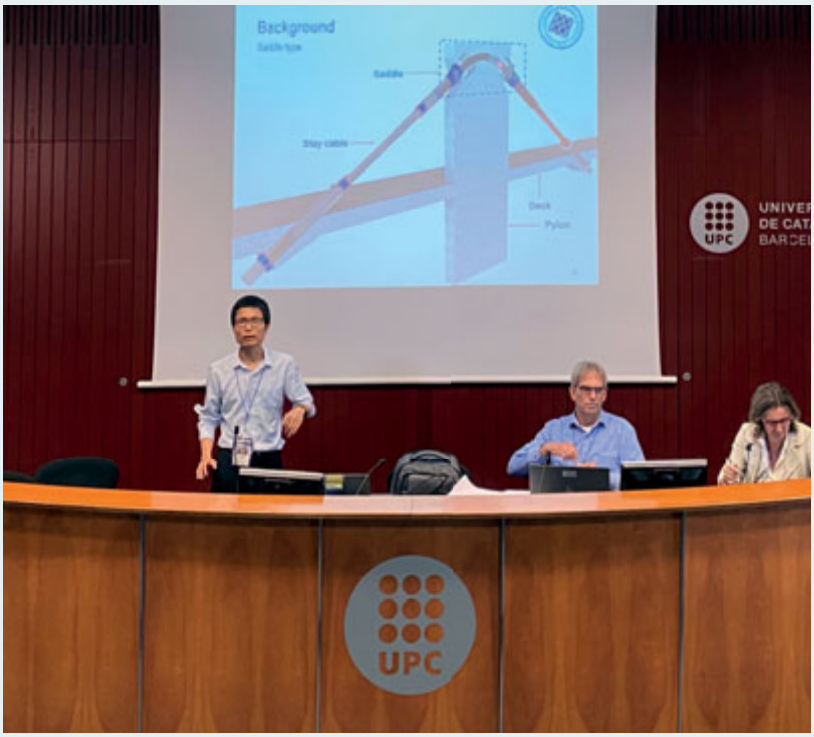
For example, testing of the BBR HiAm DINA parallel wire stay cable system developed in 1975 was undertaken later that decade. Axial fatigue and subsequent static tests were carried out using 102 and 55 wires – and the loadings applied were actually higher than those specified much later by the PTI requirements in 1986. None-the-less, no wire failure occurred during the fatigue test and the samples achieved over 100% GUTS in the subsequent static tests (Birkenmaier & Narayanan, IABSE 1982).

In fact, on the HiAm-DINA system alone, over 100 fatigue and static tests on stay cables of sizes up to 295-wire (7mm diameter) and up to 307-wire (¼" diameter) were conducted with different upper stress levels, varying stress ranges and numbers of load cycles.

Then there was the BBR HiAm parallel strand stay cable system for which axial fatigue testing was conducted in 1970 – a full 16 years before the first international recommendations were published. This involved 85-strand cables being subjected to 2.1 million load cycles. The results ultimately confirmed the excellent fatigue resistance and reliability – and qualified the BBR system for use in the construction of the Olympic Stadium Roof project in Munich, Germany. Research and development work, including project-based studies, has never stopped since then.

3

4



5

6

One of the landmark testing sessions took place in 1999. At that time, it was necessary to conduct axial fatigue and subsequent static tests according to the PTI recommendations on a 91-strand BBR HiAm stay cable, which was one of the cable sizes used in three projects – the Rama VIII Bridge in Bangkok, the Seri Saujana cable-stayed arch bridge in Putrajaya, Kuala Lumpur and the Juan Bosch Bridge in Santo Domingo. Naturally, thanks to being ahead of the game, the BBR stay cable came through the tests with flying colors.

In the early years of the new millennium, *fib* Bulletin, 1st edition 2005 (*fib* 30) was published. Alongside this publication, BBR successfully completed fatigue and subsequent static tests on different sizes of stay cables from small (e.g. with 7 strands) to median (e.g. with 61 strands).

Next, a major development was to take place which would revolutionize the whole stay cable industry and clearly map the course towards today's very latest technology.

New stay cable era dawns

In 2008, the BBR HiAm CONA strand stay cable system was introduced. It was an all-new system featuring an innovative solution for sealing of individual strand that was successfully proved in the leak tightness test following *fib* Bulletin 30 criteria, together with the highest capacity, most compact and widest range of anchorages on the market. Meanwhile, in true BBR fashion, R&D work continued and went beyond the recommendation within *fib* Bulletin 30. This included continuous fatigue and subsequent static tests on different sizes of the HiAm CONA system, on the HiEx system – and the introduction of the HiEx saddle. Then there were long-term fatigue tests up to 50 million cycles and also testing of the fatigue resistance of BBR damping systems. In fact, we did not rest until we had proven that HiAm CONA was simply the best technology on the international stay cable market.

All through this effort, we have shared our passion for stay cable technologies during global dialogues. We are regular contributors to various international forums. For us, quality, longevity and best practice are important issues because, as we have all too recently seen, there is a high price to pay when stay cable installations do not stand the test of time. ›

World first compliance to *fib* 89

We welcomed the publication of the 2nd edition of *fib* Bulletin 89 in 2019. At the same time, we accelerated the full qualification of the BBR HiAm CONA strand stay cable system according to these latest and well-accepted international recommendations. Testing highlights have included those opposite.

This means that now the full size range (001 to 217) of the HiAm CONA stay cable system has been fully tested and qualified according to the new *fib* Bulletin 89 recommendations. As stated earlier, BBR HiAm CONA is currently the only system in the world to have these credentials.

But that's not all. The BBR stay cable offering also includes advanced saddle solutions – BBR HiEx and BBR HiBox – that have completely eliminated the risk of fretting fatigue failure as seen with traditional friction saddles. Consequently these advanced saddle solutions are exempted from the stringent testing requirements placed on friction saddles within *fib* Bulletin 89.

Highlights

2019

Fatigue and subsequent static test on HiAm CONA system with 19 strands for extradosed applications. Completed without even a single wire failure during the two million load cycles, 100% GUTS achieved in subsequent static test. Testing continued beyond requirements and was only halted for machine safety reasons.

2020

Fatigue and subsequent static test on HiAm CONA system with 91 strands. This involved subjecting the stay cable to two million load cycles at a 200MPa fatigue stress range. The passing criteria allowed a maximum of 2% wire failures (12 wires). The results were astonishing – not even a single wire was broken during the two million load cycles and in the subsequent static tensile test, 100% GUTS was achieved.

2020

Bending fatigue test on HiAm CONA stay cable with 19 strands. The stay cable successfully passed the extremely challenging *fib* Bulletin 89 bending fatigue test, without requiring any alteration to the testing rig setup – that means true two-way (+/-) dynamic bending angle fatigue to capture real-life stay cable behavior. Once again no wires were broken after the two stages of bending fatigue – that is, 100,000 bending cycles with angles of +/- 1.4° and two million bending cycles with angles of +/- 0.6° – and, again, 100% GUTS was achieved in the subsequent static test.

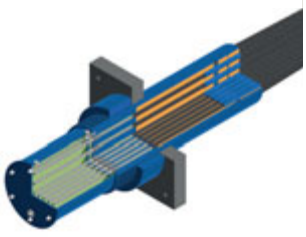
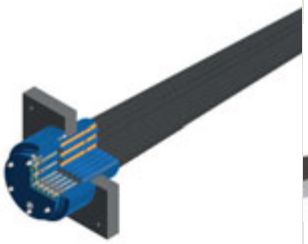
2021

Fatigue and subsequent static testing was also carried out on the new generation of BBR Pin Connector with 19 strands including components for adjustability. Again no wire failure was detected during two million load cycles and also in the subsequent static test. The test was stopped for safety reasons after having reached the target load.

2022

World record size test involving both fatigue and subsequent static test on a BBR HiAm CONA stay cable with 151-strands. After two million load cycles with a 200MPa fatigue stress range, there was not even a single wire failure – despite the *fib* acceptance criteria of 2% permissible wire failures (21 wires). In the subsequent static test, the stay cable also achieved almost 100% GUTS – again without a single wire failure. The test continued beyond the requirements and was eventually only stopped for reasons of machine safety.

Advanced solutions with BBR HiAm CONA stay cable range

BBR HIAM CONA NUT HEAD ADJUSTABLE ANCHORAGE	BBR HIAM CONA UNI HEAD SHORT SOCKET NON-ADJUSTABLE ANCHORAGE	BBR HIEX CONA SADDLE	BBR HIBOX CONA SADDLE
			

Going beyond

On top of the standard tests required for *fib* Bulletin 89 compliance testing, the BBR R&D team has carried out successful long-term fatigue tests with up to 50 million cycles – for both stay cable and extradosed applications. These have confirmed the excellent performance of the BBR HiAm CONA system for bridges with heavy traffic loads, where fatigue loading can reach 10 million cycles or even higher.

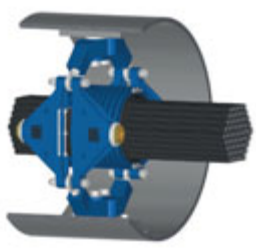
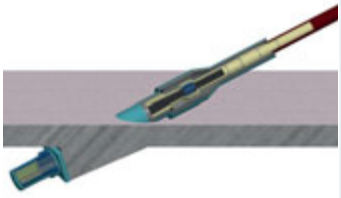
In addition, further tests have been carried out to verify the high performance of other BBR HiAm CONA system features. One of these important features is the BBR Damping range, including the BBR Viscous Damper and BBR Square (or friction) Damper, which helps to manage excessive vibration caused by live loads and wind effects. The endurance of both dampers has been experimentally proven in fatigue resistance tests of up to two million load cycles. Tests on corrosion protection and damper performance under different temperature conditions have also been conducted for some project-specific requirements.

Apart from the protection of stay cables under fatigue and dynamic loads, BBR FireShield also guarantees the cable performance under elevated temperatures as high as 1100°C (hydrocarbon fires). This has been proven in two types of test according to international recommendations, e.g. PTI DC 45.1-18, including a high-temperature strength test and an insulation system test. The tests showed that the BBR HiAm CONA stay cable system was able to maintain its performance for a duration much longer than the commonly-required 30 minutes with the help of BBR FireShield. Further features such as the provision of stay cable illumination and de-icing systems have also been developed by the team. In addition to the most commonly used 1,770 and 1,860MPa grades of strand, ultra-high tensile strength strands such as those of 2,160MPa grade, as well as special strands like epoxy coated ones (with or without grease and HDPE sheath), were also experimentally proven to be applicable to the HiAm CONA system. This ensures that the HiAm CONA stay cable system remains relevant and suitable for the widest range of projects in different markets.

While the BBR HiAm CONA system has achieved a world first with accreditation to *fib* Bulletin 89, BBR stay cable R&D will continue long into the future as new materials and technologies emerge – ensuring that BBR stay cable technology will always be one step ahead.

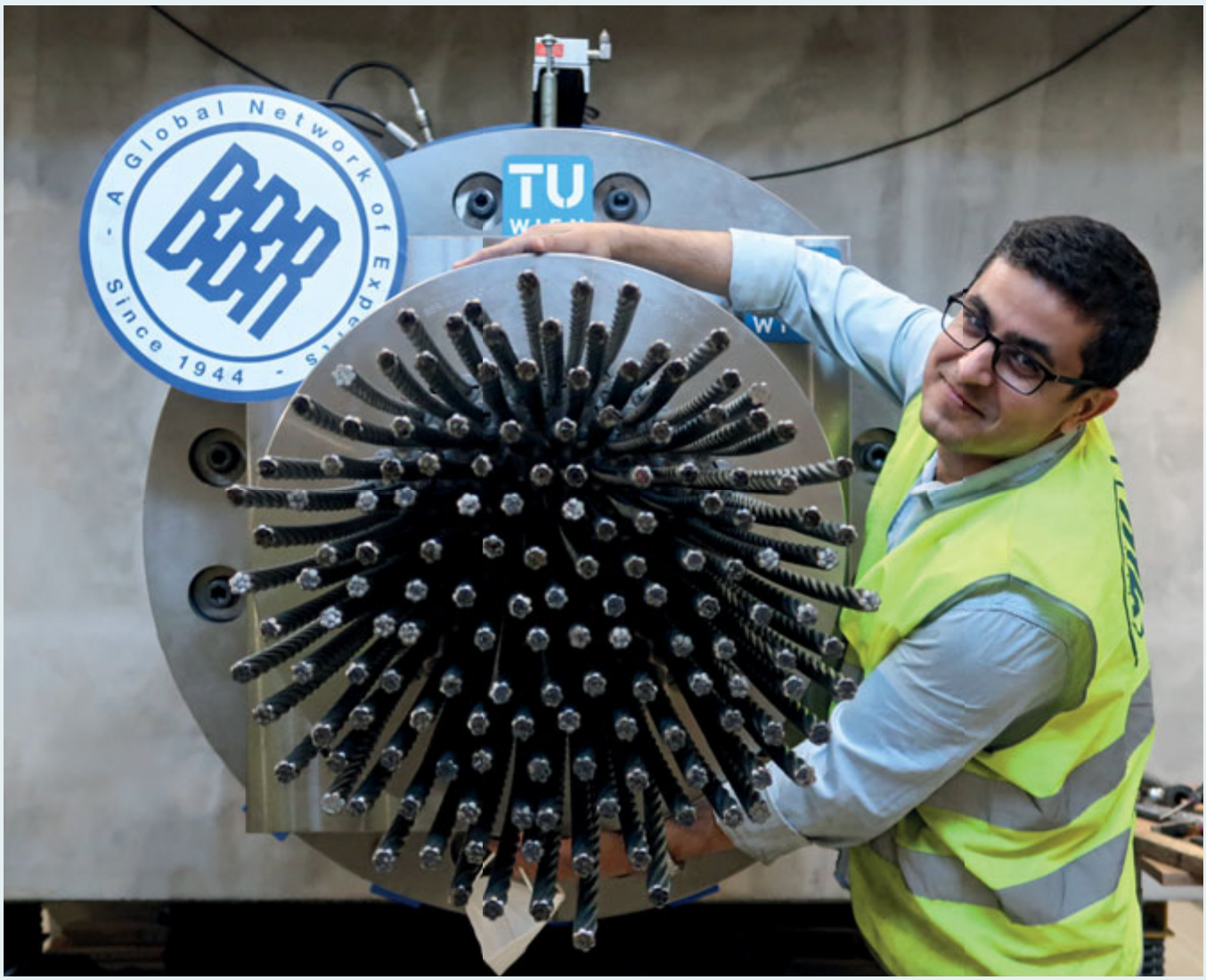
7

1 Task completed, the team pose for a quick photograph before testing of the world's largest ever stay cable begins. Left to right: Dr. Haifeng Fan, Sebastian Schinwald and Valentina Mihajlovic.
2 The first application of BBR HiAm wire stay cables (in 1971) was for the 43m main span of the Kurt Schumacher Bridge over the River Rhine at Mannheim-Ludwigshafen, Germany.
3 Tatara Bridge has the longest main span constructed in the 20th Century and was realized with 84 BBR HiAm CONA stay cables.
4 A full 16 years ahead of the first international recommendations, fatigue resistance and reliability of the BBR HiAm CONA parallel strand stay cable system was confirmed before use in the construction of the roof of the Munich Olympic Stadium in Germany.
5 Head of R&D at BBR VT International, Dr. Haifeng Fan presenting a paper on BBR's saddle solutions for eliminating fretting fatigue risk in friction saddles at the 2022 IABMAS Conference in Barcelona.
6 Rama VIII Bridge in Bangkok for which a 91-strand BBR HiAm stay cable was tested in 1999 with successful results.
7 One of the newest bridges to feature BBR HiAm CONA stay cables is the Pulau Poh Bridge in Malaysia – winner of the 2022 BBR Network Project of the Year Award.

BBR SQUARE DAMPER	BBR VISCOUS DAMPER	BBR HIAM CONA PIN CONNECTOR – FIXED, ADJUSTABLE & SINGLE-OR DOUBLE-ENDED	BBR FIRESHIELD
			

Decade of development

Today, the BBR portfolio of post-tensioning, stay cable and geotechnical solutions is unrivaled in the international market place. This leading position has been achieved by listening to customers' needs, through researching and designing technological solutions as well as, of course, with significant investment. The past 10 years have seen some major introductions into the range, along with some 'world first' achievements. In this feature, BBR VT International's Chief Technology Officer Behzad Manshadi highlights just a few of these.



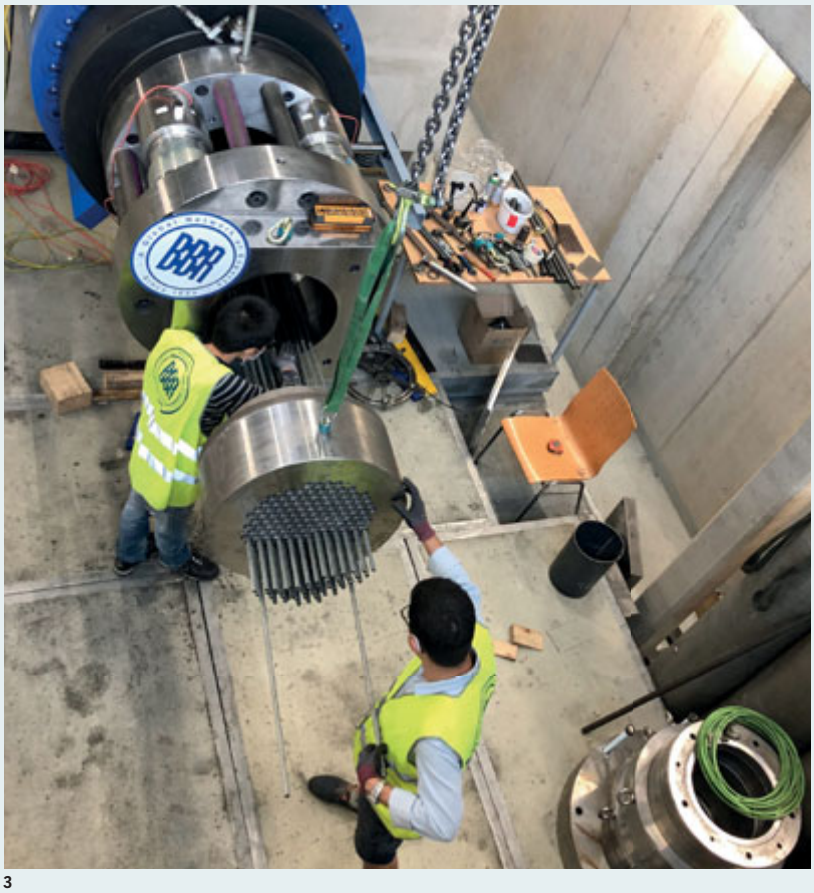
1

As the years pass, how often do we stop to reflect on what we have achieved? The answer is rarely. All too often, we go about our daily work and are constantly striving for the next goal – yet do not look back. Last year, I celebrated my tenth anniversary with BBR VT International and took the opportunity to examine exactly what progress had been made in that time.

On the post-tensioning front alone, we have extended the CONA CMI and CONA CME systems and introduced five completely new systems. Meanwhile, into the HiAm CONA stay cable family we've introduced five new features. The BBR Geotechnical range has also been enhanced with the introduction of the CONA CMG strand ground anchor system, along with three new products in the BBR Bar family.

In all, there have been over 20 major developments within the BBR product portfolio in the past decade and these reflect not only the advances in construction technology, but also the accelerated rate of development made possible through new digital technologies, material development and more importantly professional production techniques, which underpin the evolution of many new products today.

2



3

Independent testing

The work of the R&D team has not just involved designing new systems and components. It goes way beyond this and includes independent testing of the various new technologies – while ensuring continuity of their compliance or certification to the relevant European and international standards.

In this area, we have achieved two major 'world firsts'. In 2021, the CONA CMG strand ground anchor was the first such system to be tested and certified to ETA status. This achievement followed our contribution to the European Assessment Document (EAD) for strand ground anchors. Then, in 2022, we achieved full compliance with the recommendations of *fib* Bulletin 89 for the full range of HiAm CONA stay cable system – after what seemed like a marathon of testing sessions. By undertaking these time-consuming and costly processes, we absolutely know that our technologies offer customers maximum performance and durability.

The eventual result is the delivery of leading edge solutions for building new green and economical structures, helping the world in generating different kind of green energies and more importantly protecting the built world.

Green while economical approach to PT

The developments undertaken within the BBR post-tensioning portfolio have been wide-ranging. Our aim was to maintain, and improve the existing solutions and build-out the technologies to offer new advanced generations of products that were ideally suited to most applications. This holistic approach ensures that the least amount of resources are needed, effectively right-sizing the post-tensioning to specific tasks. Beyond this, there were always considerations of providing economical solutions with substantial material saving, labor time and costs and stock maintenance as well as offering the most optimized designs that result in a reduction in the amount of concrete used and consequently reducing CO_2 emissions and related impacts on the environment. With this approach, we have developed several systems i.e. CONA CMO, CONA CMM S2 and CONA CMF S2 systems, which already in a few years have been massively used for millions of square meters of thin post-tensioned slabs in applications such as suspended slabs in car parks, apartment buildings, commercial office space and retail centers, as well as slabs-on-grade in warehouses.

Stay cable advances

Over the last decade, several new elements have been developed for BBR stay cable systems including a new generation of HiAm CONA Pin Connectors with fixed and adjustable anchorages, BBR Viscous Dampers, the BBR HiBox advanced saddle solution, BBR FireShield system for fire protection purposes, HiAm CONA Uni Head Short Socket and BBR HiAm CONA with ultra-high tensile strength strands like 2,160MPa grade, as well as special strands such as epoxy coated ones.

While BBR stay cable R&D activities will continue long into the future as new materials and technologies emerge – ensuring that BBR stay cable technology will always be one step ahead – an enormous testing campaign was carried out. The purpose of this was the full qualification of the BBR HiAm CONA strand stay cable system according to the latest and well-accepted international recommendations. This means that now the full size range (001 to 217) of the HiAm CONA stay cable system has been fully tested and qualified according to the new *fib* Bulletin 89 recommendations. BBR HiAm CONA is the first – and currently the only – system in the world to have these credentials.

4

5

Launching all-new GT

A great effort went into producing a meaningful EAD for strand ground anchor kits: EAD 160071-00-0102. Meanwhile, the whole BBR R&D team is proud to be the producer of the world's first ETA approved double corrosion protected, strand ground anchor system – CONA CMG. This system offers state-of-the art performance, including a wide size range across three different corrosion protection levels, number of innovations to ensure the highest corrosion protection and durability performance while being economical. Now, for the first time, customers have the ability to make a genuine qualitative judgment when specifying strand ground anchoring work – and can also have greater confidence in the durability of their chosen solution.

Driving sustainability in construction

It is very clear that the BBR R&D team continues in the development of highly advanced systems and technologies with the main focus on sustainability in construction. In this quest, they engage with themes of digitalization, durable construction systems, maintenance, repair and retrofitting. The eventual result is the delivery of leading edge solutions for building new green and economical structures, helping the world in generating different kinds of green energies and more importantly protecting the built world.

You will, by now, sense that there's a great deal of pride in the success of all these achievements. However, thanks must also go to the R&D team, other BBR HQ colleagues and BBR Network Members around the world for their support and for sharing the vision of making the built world a better place by using the latest, smartest construction technology and methods. Let's see what we can achieve together in the next ten years!

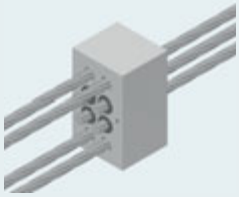
1 BBR VT International CTO Behzad Manshadi has had his arms around many BBR technological developments over the past decade. This shot was taken just before testing of the world's largest stay cable – a 151 (x 15.7mm diameter) strand HiAm CONA stay cable – began.
2 The BBR VT CONA CMG system has the world's first ETA approved double corrosion protected, strand ground anchor. It is used for many applications, including dam strengthening and as a hold-down solution for wind towers.
3 The HiAm CONA stay cable system has been tested across the whole size range to *fib* Bulletin 89 recommendations – and is currently the only system in the world with this distinction.
4 Extensive testing of CONA CMI tendons was undertaken to prove their performance at cryogenic temperatures. They have been used to post-tension many LNG tank installations.
5 The innovative CONA CMM S2 monostrand post-tensioning system, introduced in 2017, has now become the solution of choice for many construction projects worldwide.

R&D Milestones

Geotechnical · Post-Tensioning · Stay Cables

In just ten years, the BBR R&D team has produced an astonishing range of technologies which take the construction industry further towards its goals for carbon reduction and greater productivity. Some of the highlights are shown here – and you can be sure that, as digitalization and materials technology continue to advance, even more milestones will be added in near future.

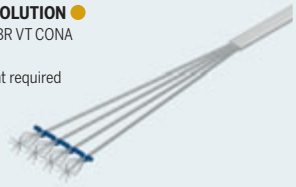
BBR VT CONA CMW – ROBUST SOLUTION
- For tank & silo applications
- No buttresses & local zone reinforcement are required
- Used with a band system for tank & silo strengthening
- Tested & verified in accordance with European Technical Guideline EAD 16.



BBR VISCOUS DAMPER
- Available in both internal & external configuration
- Capable of damping a wide range of stay cable sizes & lengths with various damping forces

BBR HIAM CONA UNI HEAD ANCHORAGE
- An optimized design with a shorter socket, optimized anchor head
- Fully in compliance with *fib*, PTI and CIP Setra recommendations

BBR VT CONA CMO – ECONOMICAL SOLUTION
- Fixed-end anchorages compatible with BBR VT CONA CMF, CMI SP & BT systems
- No anti-bursting or splitting reinforcement required
- Equipped with innovative clip-lock design of the bulb-strand spacer
- European approved & CE marked



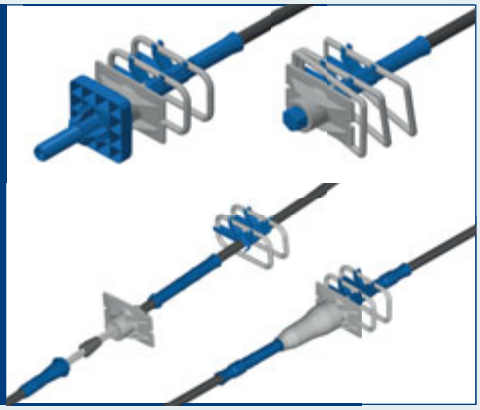
2013 | 2014 | 2015 | 2016 | 2017

BBR VT CONA CMI – CRYOGENIC APPLICATIONS
- Entire multistrand tendon & load transfer concrete fully submerged into a liquid nitrogen bath & subjected to cryogenic temperature (-196°C)
- Verifying superior ductility of BBR VT CONA CMI in full compliance with EAD 16

BBR VT CONA CMI & CME – ELECTRICALLY ISOLATED TENDON (EIT)
- European Technical Assessment & CE marked & in full compliance with *fib* 75
- Superior long-term durability with highest possible protection level (PL3)
- Continuous monitoring of impedance provides an early detection warning system
- Most compact & light-weight system available
- Complemented with electrically isolated coupling anchorages (Types H&K)

BBR VT CONA CMX – FULL ACCESSORY RANGE
- Improve efficiency & sustainability
- Ensure durability of the post tensioning systems
- Enhance construction process & reduce labor costs
- Provide cost-effective solution

BBR VT CONA CMM S2 – HOLISTIC SOLUTION
- European Technical Assessment & CE marked
- Innovative accessories to reduce labor and material costs
- Compact light-weight anchorages
- Offers the smallest center spacing in the market
- No anti-bursting or splitting reinforcement
- Full stressing at very low concrete strength
- Monolithic coupling & intermediate anchorages
- Bonded & unbonded applications
- Superior corrosion protection details

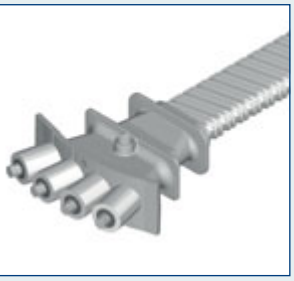


BBR BAR FAMILY – H BAR SYSTEM

- Widest range of bar grades & diameters from 20mm up to 75mm
- Robust thread appropriate for ground applications (temporary and permanent)
- High quality with superior fatigue performance
- Full range of accessories
- Testing & quality assurance according to international standards

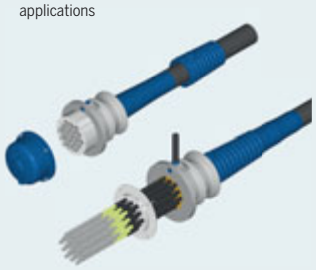
BBR VT CONA CMF S2 – HOLISTIC SOLUTION

- European Technical Assessment & CE marked
- Thinnest slab thickness
- Widest anchorage & coupler size range on the market
- Full stressing at very low concrete strength
- Saving material, labor cost & stock maintenance
- Compact light-weight anchorages
- Bonded & unbonded applications
- Compatible with both corrugated steel & plastic ducts



BBR VT CONA CMI/CME – GROUTED WITH MONOSTRAND/EXCHANGEABLE

- European Technical Assessment & CE marked
- Restressable & exchangeable strands
- Smallest radius of curvature
- Multiple layers of corrosion protection – duct, grout and finally monostrand
- Superior solution for bridge strengthening applications



BBR HIBOX SADDLE – SOLUTION WITH NO FRETTING FATIGUE CONCERN

- Designed according to national or international standards
- No access inside pylon is needed – slim & elegant pylon
- Cable installation & replacement independently on either side of pylon
- Full inspection & maintenance of anchorage components
- Strand-by-strand replacement is not only feasible, but it is also simple
- In full compliance with *fib* recommendation

BBR HIAM CONA – FIRST & ONLY STAY CABLE SYSTEM IN FULL COMPLIANCE WITH *FIB* BULLETIN 89

Across the full size range (001 to 217), the HiAm CONA stay cable system, is the first & currently the only system in the world which has been fully tested & qualified according to the new *fib* Bulletin 89 recommendations.

2018 | **2019** | **2020** | **2021** | **2022**

BBR BAR FAMILY – SDX, C & WT BAR SYSTEMS

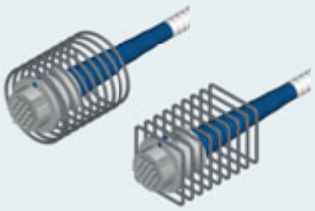
- Self-drilling R- and T-threads are compatible with any easily available drilling machines & ensure excellent grout bonding
- Widest range of diameters & with full range of accessories
- Multi-level corrosion protection for different lifespan expectations
- Proven performance beyond requirement by testing & quality assurance according to international standards
- Tested & proven high fatigue performance
- CE marking for C bar according to EN 1090

BBR PIN CONNECTOR – NEW GENERATION

- Fixed & adjustable pin connectors
- Aesthetically pleasing & very slender stay cable appearance
- Superior axial & bending fatigue resistance
- System assessed & in full compliance with the latest *fib*, PTI and CIP (Setra) recommendations

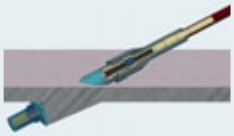
BBR VT CONA CMI & CME – HIGH CONCRETE STRENGTH WITH ONE LAYER OF REINFORCEMENT

- Reduce congestion in the anchorage zone
- Both helix-only & stirrup-only solutions that give freedom for designers
- Most compact design on the market (lowest center spacing and reinforcement dimensions)
- Widest size range on the market



BBR FIRESHIELD

- Guaranteed performance under extreme conditions of hydrocarbon fires
- Applicable for both existing & new cables
- Ease of installation, inspection & replacement
- Test proven according to international guidelines i.e. PTI, *fib*
- Applicable for fire protection of external post-tensioning tendons



BBR VT CONA CMG – FIRST & ONLY ETA APPROVED GROUND STRAND ANCHOR IN THE WORLD

- Unique-in-the-market corrosion protection features
- Fully ETA-approved & CE-certified system
- Effective double corrosion protection solution for permanent applications – due to proven limitation of grout cracking
- Widest range of anchorage sizes

Insight Evolution of BBR E-Trace trading platform

Digital delivers for BBR

While the rush by some businesses to introduce digital technologies began relatively recently, BBR had already begun digitalization by developing and launching their own custom-built online trading platform in 2009. Meanwhile, the result of this advanced thinking, BBR E-Trace, has become central to the business activities of the BBR Network. BBR VT International CTO, Dr. Behzad Manshadi explores the development of the platform and the ways in which it has improved the whole supply chain scenario, enhancing value for BBR Network Members and their customers.

BBR E-Trace was first introduced as an integral part of the BBR VT CONA CMX quality assurance process. It was an internet-based platform, designed and built to the specific requirements of the BBR Network. Its purpose was to provide a quality management system including full traceability and document control of CE-marked BBR post-tensioning systems – but paperless.

Evolution – then revolution

Right from the start, our strategy was always to evolve the capabilities of this unique e-commerce platform wherever it is needed – rather like our approach to our construction technologies. When launched in 2009, BBR E-Trace was a web-based platform dealing with just a few hundred CONA CMX post-tensioning parts. Today this platform includes more than 3,000 components while offering greater functionality and more supply chain management features than ever before.

Over the past five years, along with the unveiling of the new BBR Global Supply Chain setup, BBR E-trace has undergone several substantial evolutions that have totally revolutionized our customized web- and mobile-based application, turning it into a powerful supply chain and procurement management tool. In addition, customer relationship management (CRM) solutions have been designed and integrated into each of its key areas to enhance any supply chain management solution, production and quality, logistics and delivery, buyer-supplier commercial relationships – all successfully meeting the needs of our customers who are specialist contractors. This did not just happen overnight, it was a progressive evolution informed by the direction and challenges of the business. We wanted to explore the possibility of making all aspects of the supply chain operation more efficient – without adding cost, but with a vision of autonomous trading. At the same time, we wanted to allow room for future growth and for new developments. The best solution was a modular approach which will facilitate the addition of new functionality whenever needed.

1

BBR E-Trace today

BBR E-Trace as a management tool with key features manages the connections and interactions between all the key teams involved, for the whole BBR Network business all over the world – including component manufacturers, quality control teams, logistic/inventory teams, accounting and supply chain management teams and finally BBR specialist contractors, as shown on the adjacent diagram.

In brief, BBR E-Trace is now a modular-digitalized supply chain management tool with several capabilities. Designed for B2B and B2C commerce and to allow for customization, it has been simplified to allow fast adoption of new technologies and solutions in order to always meet the latest customer supply demands in the best and most efficient way. Furthermore, it's a scalable solution that assists scalability of BBR Network businesses, while keeping supply chain costs down. All-in-all, it's a recipe for maximum efficiency and competitiveness.

2

Glimpse into future

Development work is already well underway to equip our modular digital management tool with further advanced modules and functionalities, for example BBR digital signature for authentication of BBR components, BBR design tool and more.

From a simple and early start with digitalization, we now have the most advanced and flexible management tool. This unique platform which has been driving the digitalization of our business was conceived and implemented thanks to the insight of the management team back then – particularly Marcel Poser and Dr. Antonio Caballero. Furthermore, we recognize the dedication of the supply chain management team at BBR HQ and also thank BBR Network Members for their valuable feedback which continues to support the further evolution of this pioneering and powerful platform. Meanwhile, our commitment to further investing in BBR E-Trace continues, but more about this later!

Fast facts: BBR E-Trace

Autonomous system – for most trading processes (ordering, logistics, invoicing, forecasting, stock management, pricing).

Search tool – robust & strong, with proper filtering features, kit generators.

Full traceability – offering complete track record of Factory Production Control (FPC) and easy part localization and more.

Quality control management tool – full functionality for CE-marked products (QC, PDI, materials certificates, CE certification & conformity of performance).

Inventory management tool – allows stock to be managed effectively through central warehouses as part of the global supply chain.

Forecasting tool – enables fast data collection and precise analysis to secure a proper stock level in our warehouses thus ability to supply our clients with short lead times.

Cost management tool – facilitates the cost calculation with live pricing available anytime, anywhere.

Contract management tool – manages the legal agreements between different parties/teams involved.

Robust reporting tool – provides relevant reports to each of all the teams involved.

Special features – covering management of construction site installation & specialist contractor stock.

Rich technical database – including drawings, standards, guidelines, method statements and more.

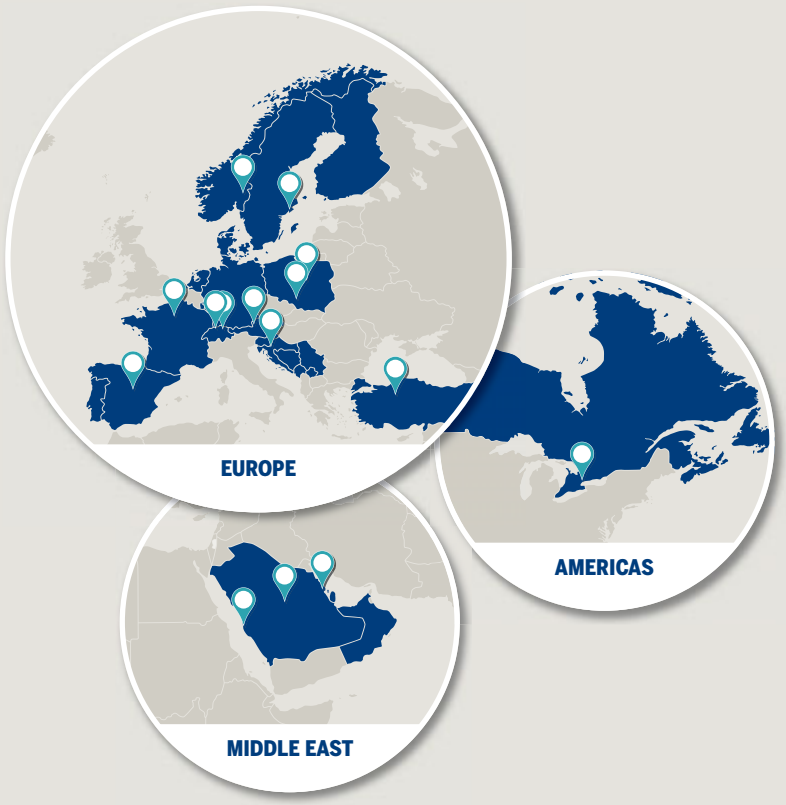
3

1 Digital transformation – by 2009, BBR had not only developed, but had also launched their own web-based trading platform – BBR E-Trace.
2 BBR E-Trace – many capabilities, one platform. BBR is uniquely placed with a modular digital management tool that can adapt and grow with the business.
3 After several substantial evolutions, BBR E-Trace has now become a powerful supply chain and procurement management tool with CRM integration – minimizing costs and maximizing efficiency.

Our global presence

Our clients are based in over 50 countries – so our global presence is a vital asset.

We can share our international experience locally, provide solutions adapted to specific conditions and be on hand to offer a personalized service.



HEADQUARTERS

BBR VT International Ltd
Ringstrasse 2
8603 Schwerzenbach-Zurich
Switzerland
Tel +41 44 806 80 60
Fax +41 44 806 80 50
www.bbrnetwork.com
info@bbrnetwork.com

EUROPE

AUSTRIA
KB Vorspann-Technik GmbH
Weitwörth 25
5151 Nussdorf a.H.
Tel +43 6272 407 90
Fax +43 6272 407 90 11
www.kb-vt.com
office@kb-vt.com

BOSNIA & HERZEGOVINA
see Croatia

CROATIA
BBR Adria d.o.o.
Kalinovica 3
10 000 Zagreb
Tel +385 1 3839 220
Fax +385 1 3839 243
www.bbr-adria.com
bbr-adria@bbr-adria.com

DENMARK
see Norway

FINLAND
see Norway

FRANCE
ÆVIA – Etablissement Câbles et Manutention
3-7 Place de l'Europe
78140 Vélizy-Villacoublay
Tel +33 1 71 59 51 30
www.eiffage-aevia.com
etic.aevia@eiffage.com

GERMANY
see Austria

KOSOVO
see Croatia

LIECHTENSTEIN
see Switzerland

LUXEMBOURG
See France

MONTENEGRO
see Croatia

NORWAY
KB Spennteknikk AS
Siva Industrial Estate
Norvald Strands veg 19-21
Postboks 1213
2206 Kongsvinger
Tel +47 62 81 00 30
Fax +47 62 81 00 55
www.spennteknikk.no
spennteknikk@spennteknikk.no

POLAND
BBR Polska Sp. z o.o. (Head Office)
ul. Annopol 14
03-236 Warszawa
Tel +48 22 811 50 53
www.bbr.pl
bbrpolska@bbr.pl

BBR Polska Sp. z o.o.
ul. Tarnogórska 214a
44-105 Gliwice
Tel +48 32 331 47 98
www.bbr.pl
bbrpolska.gliwice@bbr.pl

PORTUGAL
see Spain

SERBIA
see Croatia

SLOVENIA
see Croatia

SPAIN
FCC Construcción
Antigua Carretera N-IIIm Km. 31,150
28500 Arganda del Rey
Madrid
Tel +34 91 876 09 00
Fax +34 91 876 09 01
www.bbrpte.com
bbrpte@bbrpte.com

SWEDEN
Spännteknik SLF AB
Koppsängsvägen 13
671 93 Arvika
Tel +46 8 510 678 10
Fax +46 8 510 678 19
www.spannteknik.se
info@spannteknik.se

SWITZERLAND
Stahlton AG
Hauptstrasse 131, 5070 Frick
Tel +41 44 938 99 00
Fax +41 44 938 99 01
www.stahlton.ch
bautechnik@stahlton.ch

TURKEY
Kappa Kalip Insaat Ve Taahhut A.S.
Beytepe Mah. 5387. cad,
Mira Ofis A Blok No: 15/49
06800 Çankaya/Ankara
Tel +90 312 963 00 33
www.kappa.gen.tr
info@kappa.gen.tr

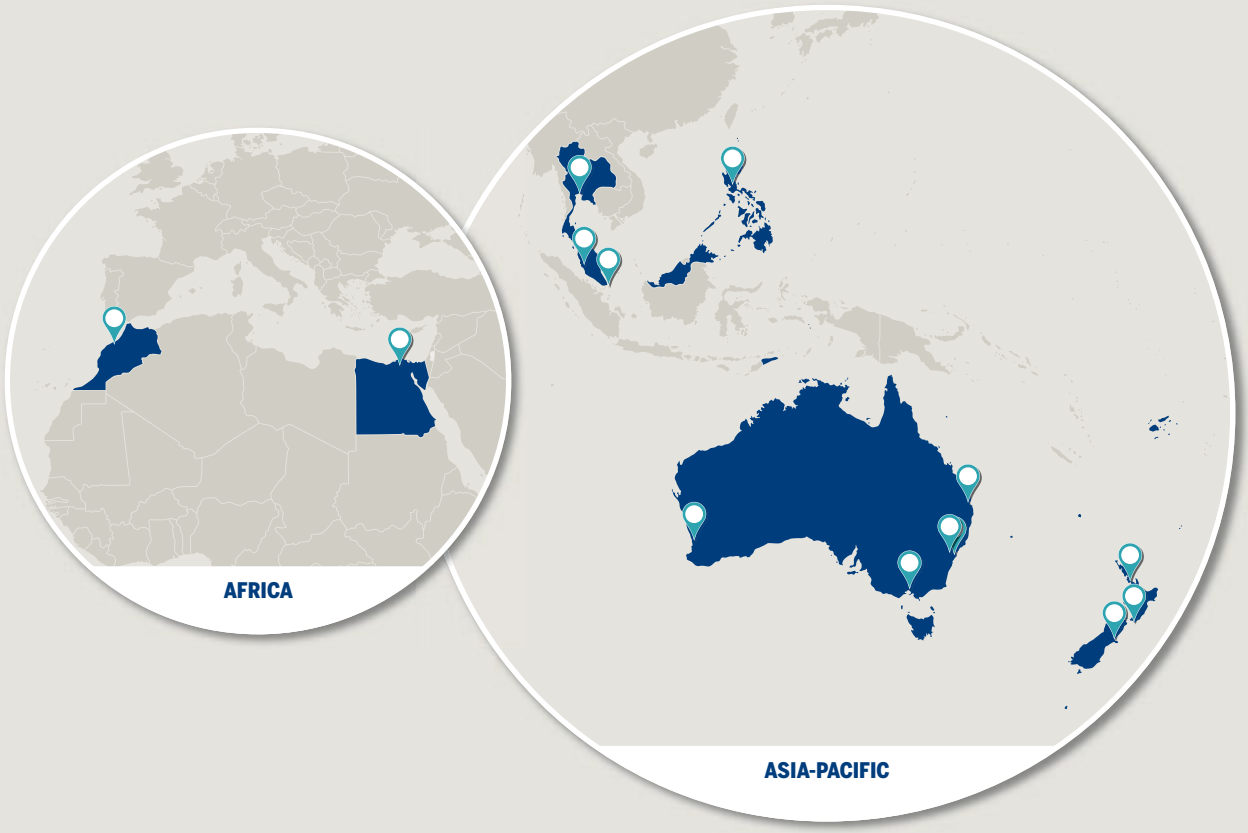
AMERICAS

EASTERN CANADA
Canadian bbr Inc.
3450 Midland Ave.
Scarborough, Ontario M1V 4V4
Tel +1 416 291 1618
Fax +1 416 291 9960
mducommun@bbrcanada.com

AFRICA

EGYPT
ESPT
43 Moez Al Dawla Street
Nasr city, Cairo
Tel +20 106 094 1272
+20 100 450 5820
Fax +20 2 267 102 51
www.bbrnetwork.com

MOROCCO
Becomar
Rue Al Adarissa
Berrechid
Casablanca 26100
Tel +212 522 324 024 / 26
www.becomar.net
contact@Becomar.net



MIDDLE EAST

BAHRAIN
BBR Bahrain
see Kingdom of Saudi Arabia

QATAR
BBR Qatar
see Kingdom of Saudi Arabia

KINGDOM OF SAUDI ARABIA
BBR Saudi Arabia
Olaya Street, As Sahfah
HDB Hotel, 1st Floor
Riyadh
Tel +966 11 293 4400
+966 11 461 1144
M +966 55 808 0101
www.bbrgulf.com
info@bbrsti.com

BBR Saudi Arabia
Al Khalidyah, Al Kayan Building
3rd Floor
Jeddah
Tel +966 12 236 7880
M +966 55 808 0101
www.bbrgulf.com
info@bbrsti.com

BBR Saudi Arabia
Prince Sultan Street, Sidra Complex
4th Floor, Office 401
Al Khobar
M +966 55 808 0101
www.bbrgulf.com
info@bbrsti.com

ASIA-PACIFIC

AUSTRALIA
SRG Global
Level 2, 500 Hay Street
Subiaco, WA 6008
Tel +61 8 9267 5400
Fax +61 8 9267 5499
www.srgglobal.com.au
info@srgglobal.com.au

SRG Global
Suite 3, Level 1,
75 Carnarvon Street
Silverwater, NSW 2128
Tel +61 2 8767 6200
Fax +61 2 8767 6299
www.srgglobal.com.au
info@srgglobal.com.au

SRG Global
18 Lions Park Road, Yatala
Queensland 4207
Tel +61 7 3442 3500
Fax +61 7 3442 3555
www.srgglobal.com.au
info@srgglobal.com.au

SRG Global
2/290 Salmon Street
Port Melbourne
Victoria 3207
Tel +61 3 9296 8100
Fax +61 3 9646 7133
www.srgglobal.com.au
info@srgglobal.com.au

SRG Global GT (Product Division)
Unit 2B, 14 Pavesi Street, Smithfield
NSW 2164
Tel +61 2 8767 6200
Fax +61 2 8767 6299
www.srgglobal.com.au
info@srgglobal.com.au

FIJI
see New Zealand

MALAYSIA
BBR Construction Systems (M) Sdn Bhd
No.17, Jalan Sg. Jeluh 32/191
Kawasan Perindustrian Kemuning
Seksyen 32
40460 Shah Alam
Selangor Darul Ehsan
Tel +60 3 5525 3270
Fax +60 3 5525 3285
www.bbr.com.my
enquiry@bbr.com.my

NEW ZEALAND
BBR Contech
15 Kerwyn Ave, East Tamaki
Auckland 2013
Mailing address: PO Box 51-391,
Pakuranga, Auckland
Tel +64 9 274 9259
www.contech.co.nz
akl@contech.co.nz

BBR Contech
27 Port Road, Seaview
Lower Hutt 5010
Wellington
Mailing address: PO Box 30-854,
Lower Hutt, Wellington
Tel +64 4 569 1167
Fax +64 4 569 4269
www.contech.co.nz
wgn@contech.co.nz

BBR Contech
40 Depot Street
Hornby South
Christchurch 8042
Mailing address: PO Box 8939,
Riccarton, Christchurch
Tel +64 3 339 0426
Fax +64 3 339 0526
www.contech.co.nz
chc@contech.co.nz

PHILIPPINES
BBR Philippines Corporation
Suite 502, 7 East Capitol Building
No.7 East Capitol Drive
Barangay Kapitolyo
Pasig City
Metro Manila 1603
Tel +632 8638 7261
Fax +632 8638 7260
info@bbr.com.ph

SINGAPORE
BBR Construction Systems Pte Ltd
BBR Building
50 Changi South Street 1
Singapore 486126
Republic of Singapore
Tel +65 6546 2280
Fax +65 6546 2268
www.bbr.com.sg
enquiry@bbr.com.sg

THAILAND
Siam BBR Systems Co. Ltd
No.449, 2nd Floor, 559 Building
Bangpood Sub-District
Pakkred District
Nonthaburi 11120
Tel +66 80 280 8802

BBR A Global Network of Experts
www.bbrnetwork.com