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Edition 15 | 2021

CONNECT

THE MAGAZINE OF THE GLOBAL BBR NETWORK OF EXPERTS

ELEVATED POST-TENSIONING TAKES OFF IN NZ

Multi-level commercial and residential buildings

70TH ANNIVERSARY OF BBR GEOTECHNICAL TECHNOLOGY

Celebrating BBR's global achievements

HIGH PRODUCTIVITY FOR NEW BRIDGE

Cost- and time-effective solution in Poland

TRANSFERRING LOAD WITH BBR H BARS

Work at Yusufeli Dam, Turkey

BBR TENDONS STILL STRONG AFTER 45 YEARS

Nuclear inspection & testing at Ringhals

A Global Network of Experts

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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, more than 75 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.

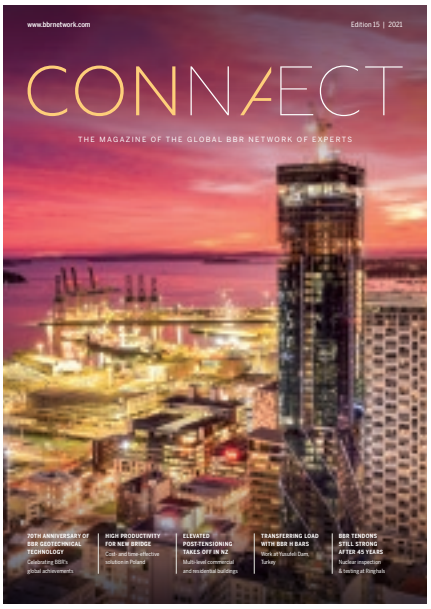
ACTIVITIES OF THE NETWORK

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 over 75 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).



Dedication meets versatility

We are delighted to welcome you to the 2021 edition of the BBR Network's CONNÆCT magazine! One thing's for sure, it's been an extraordinary year – and within the following pages, there are insights into equally extraordinary achievements all around the globe.

While many industries were forced to halt work because of the Covid-19 coronavirus outbreak, the construction industry quickly adapted its already well-developed health and safety systems to accommodate new hygiene measures and working methods. The results of this speedy adaptation can be seen in the Portfolio section where the wide diversity of projects admirably demonstrate the versatility and scope of BBR technologies and techniques.

Many bridge projects have been realized – in locations from the frozen landscapes of northern Scandinavia to sunny coastlines in the Indian Ocean. Productivity was boosted during construction of a major bridge in Poland, green objectives were achieved in Norway and technical challenges were well met in Malaysia, Australia and New Zealand, while new landmark bridges in Dubai and Auckland are set to transform waterscape panoramas.

This year, we reflect on the 70th Anniversary of the first BBR ground anchoring project and, in a special celebratory feature, are proud to showcase the achievements of BBR engineers and technologies – and offer an overview of latest BBR geotechnical strand anchor and bar technologies.

Elsewhere in this edition, you can read about record-breaking post-tensioned ground slabs in New Zealand, pioneering building projects in Singapore and Croatia and an exciting new retail center in Serbia. The strength of BBR geotechnical and bar technologies has been applied to Yusufeli Dam in Turkey and for a major development scheme in Croatia. Maritime, nuclear and structural strengthening schemes show the breadth of BBR technologies and techniques in the MRR section.

In a year that has been like no other, BBR VT International has achieved significant advances in technological development, as well as successfully testing BBR stay cable technology to the new *fib* Bulletin 89 guidelines – and ultimately proving its indestructibility!

We congratulate and thank everyone for their great contributions and huge dedication, in challenging circumstances, to an outstanding performance for customers everywhere.

Marcel Poser
Chairman, BBR VT International Ltd

José Manuel Illescas
Vice Chairman, BBR VT International Ltd

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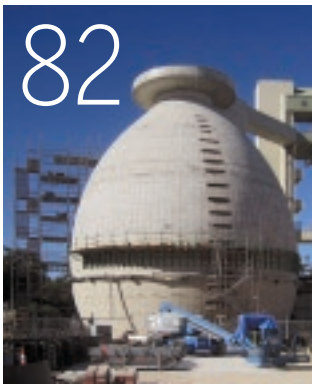
TALKING BBR

PORTFOLIO



TECHNOLOGY

THINKING ALOUD

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SOURCES AND REFERENCES
Front cover image: Pacifica Tower, Auckland, New Zealand: This stunning 57-floor mixed use tower has become a new feature on the city skyline. It was realized using BBR post-tensioning for the elevated floors and also for the lateral load resisting system, where multi-strand tendons have been tensioned to 50% of their capacity to enable building flexibility during an earthquake event. See Page 36 for the full story.

Portfolio section
Bridge at heart of community: www.inyourpocket.com. https://wooarts.com.
Stressing in the sun: https://la1ere.francetvinfo.fr.
Largest all-year resort in Croatia: www.croatiaweek.com.
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Technology section
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Business Review Reflections & outlook from BBR VT International's CEO

Adapting & realigning to the 'new reality'

In the last 12 months, we have experienced one of the greatest challenges of our generation. The Covid-19 coronavirus outbreak has disrupted daily lives and economies throughout the world. While it is not entirely over yet, we should reflect on what we have achieved and learned – and where this can take us in the future. BBR VT International CEO Juan Maier shares an insight into how BBR is adapting to the 'new reality' and focusing on harnessing further significant competitive advantages.

In every crisis lies an opportunity and BBR has been working to adapt itself to the new reality.

In every crisis lies an opportunity and BBR has been working to adapt itself to the new reality. The impact of this virus has shown that when everyone is aligned around a common purpose, operational teams can achieve goals that would have been considered impossible pre-crisis. More than ever before, we need to help our colleagues, clients and others with whom we work to reinvent our workplaces with flexible – yet productive – remote working, to build better and more resilient operations, to accelerate digitization to raise performance and to find new and sustainable competitive advantages in this age of the 'new normal'.

A simple example is that it would have been inconceivable prior to the current health crisis for businesses to operate with their people in a 'home office' mode, yet Covid-19 has shown that when this is forced upon us, it is actually possible – and in some instances has even boosted our productivity. This then leads us to reimagine the future of the workplace in which we potentially do not require the same amounts of office space – people will be able to work more flexibly or remotely from any location. Consequently, we should already start to think about what we will do with all that potentially empty office space. Most likely, it will need to be repurposed – and therein lie further opportunities for BBR to contribute by utilizing its know-how and specialized technologies to help owners to realize these changes to their assets. This is one of many examples of where BBR has been actively engaged in reimagining the future to get ahead of the opportunities before they materialize.

'Digital first' approach

One of the early key learnings that we made from living through the coronavirus situation is that, as an organization, we have to take a 'digital first' approach to everything that we do. Online and flexible working are replacing physical meetings with virtual meetings. Even our 2020 BBR Annual Global Conference was replaced with a virtual webinar and, more recently, we delivered our Project Managers' Workshop in the same way.

BBR E-Trace – the pioneering online trading platform which has been at the core of our QA/QC processes since 2009 – has supported our needs for contactless and paperless transactions. The platform is now further evolving and will shortly be able to track the BBR Digital Signature which will appear on every BBR component for product traceability, quality assurance and product authentication. We continue to rigorously explore ways in which to leverage digital technologies to increase our productivity, to differentiate our product and service offering and, in the process, to uncover new competitive advantages. ›

Innovate or die!

The Covid-19 situation has created far-reaching and massive socio-economic changes which consequently also require seismic shifts in our business models in order to adapt to the changing environment. At BBR, we realize that the main pillar underpinning the BBR franchising model is based on technology. So, as long as BBR continues to innovate, particularly in hugely changing times, then value is created and all stakeholders will benefit – stop innovating and BBR, along with its stakeholders, will die. Our innovations are always market-driven and designed to promote increased productivity, durability, cost-efficiency and safety, alongside other benefits.

... the past year saw us perform groundbreaking R&D resulting in the registration of two new patents for ground anchoring technologies.

For example, the past year saw us perform groundbreaking R&D, resulting in the registration of two new patents for ground anchoring technologies. We believe these developments will be game-changing as they raise the quality and level of corrosion protection to vital ground anchoring technologies. Moreover, the ground anchoring market is in desperate need of further product quality assurance and therefore BBR is aiming to introduce the first CE marking of its kind for the BBR VT CONA CMG strand ground anchor system.

With the introduction of the new *fib* Bulletin 89 recommendation on stay cable systems, a 91-strand BBR stay cable recently passed an axial fatigue test with flying colors, as well as easily sailing past the criteria for the new bending fatigue test imposed by the new recommendations. And, as if this were not enough, we are now in the final planning stage for an attempt at a world record-setting stay cable fatigue test which should be completed just as this edition of CONNÆCT goes to print.

Pushing at the boundaries

Now we could just rest on our laurels after merely meeting the requirements of these international standards and guidelines, but at BBR that is really not in our DNA, so of course we keep pushing the boundaries of this technology. An example of this is the development and introduction of the BBR IceShield solution for stay cable pipes. In the most extreme northern climates, there is a high risk of ice forming and falling onto pedestrians and vehicles traveling below. Our passive anti-icing solution reduces the likelihood of ice accretion and formation of ice chunks on the stay pipes thus protecting the safety of the bridge users below, while the passive nature of the solution also saves ongoing operational and maintenance costs for the asset owner.

Moving to more warmer climates, in particular where there is petrochemical production, the risk of hydrocarbon fires from tanker accidents in turn poses a risk to the structural integrity of stay cable bridges. The current state-of-the-art recommendations demand a stay cable fire protection rating, in a 1,100°C fire, of up to 30 minutes. Never satisfied with simply meeting the standards, BBR's unique fire protection system has been proven through extensive high-temperature laboratory testing to remain intact and keep the underlying critical stay cable anchorage components cool for well in excess of the minimum requirement – providing precious extra time for firefighting crews to deploy to the sites, to contain the fierce hydrocarbon fires and ultimately save the structure from total destruction. The BBR FireShield protection system is also cost-effective and versatile enough to be retrofitted to the stay cables of existing structures with minimal intervention.

Driving industry-wide regulation

The first structures built and equipped with modern stay cable systems commenced in the early 1960s. Despite the passage of over six decades, it may surprise many people to learn that stay cable systems remain largely unregulated. This has resulted in the proliferation of many different stay cable systems which simply are not reliable enough to be installed on our most valuable bridge assets which connect communities together and drive economies.

BBR is about to change this and, like the actions taken for ground anchoring technologies, we have developed a new assessment methodology for stay cable technologies with the aim of launching the first CE marking of its kind for the BBR HiAm CONA stay cable system. This action will help filter the strong from the weak stay cable system providers and, most importantly, bring confidence and quality assurance to this important technology in much the same way as when ETA and CE marking was introduced to post-tensioning technologies back in the early 2000s.

Everyone has played their part and I would like to thank all those who have stayed strong and gone the extra mile to deliver some great innovations and results during an exceptionally difficult 12-month period.

BBR family values

As well as working on technological enhancements to our product range, the BBR HQ team has continued to support BBR Network Members on a daily basis throughout the past challenging months. Among the great advantages of being a BBR Network Member is access not only to the latest construction engineering technology and BBR brand reputation, but also to sound technical advice from engineers at BBR HQ and the benefit of shared experience from other Members. Everyone has played their part and I would like to thank all those who have stayed strong and gone the extra mile to deliver some great innovations and results during an exceptionally difficult 12-month period. As the coronavirus disruptions begin to subside, we should focus on how we can bring about still further real improvements for the industry and its stakeholders – while also taking advantage of the new opportunities which will emerge as the world realigns itself in the new post-Covid-19 era. Together, we can do this!

Conference notes Virtual conference sessions

Meeting of minds

The 2020 BBR Network Webinar was a meeting of minds – rather than a physical meeting – and drew delegates from among the world's most talented construction engineers. In the light of the global Covid-19 coronavirus outbreak, the decision was taken to postpone the now traditional Global Annual BBR Conference. However, the need to communicate still remained – so the BBR Headquarters team took to the virtual stage to reveal their latest news.

Two identical Webinar sessions were arranged to cater for audiences in different time zones across the globe and key personnel from BBR VT International gave excellent presentations on a variety of topics. It was soon apparent to all delegates that, despite the challenges of recent months, some exciting developments were underway.

After a brief introduction by CEO Juan Maier who welcomed everyone to the Webinar, attendees viewed the 2020 BBR Highlights video which was premièred during this special online event.

From the live Q&A sessions after each topic, it was clear that delegates were excited to hear about the new technologies and features introduced. However, in the days which followed the BBR HQ team hosted many individual calls with BBR Network Members who were keen to find out more about how they could incorporate these latest technologies into their upcoming construction projects.

In recent months, the entire world has had to embrace new, safe ways of living and working – and maintaining effective communications has been high on the agenda. There will certainly be a time that the BBR Network can safely gather together once again – and it is sure to be an especially memorable event – but until then, BBR Headquarters is maximizing all digital communication opportunities to ensure the continuation of the valuable exchange of information around the BBR Network.

BBR NETWORK UPDATES

Daniel Cuerdo presented Business & Franchise Development news which incorporated trading reviews and the wide variety of events internationally supported by BBR HQ, plus latest marketing communications releases in print and digital media. The presentation ended with the first showing of the CONA CMB system video – completing the BBR Technical Series about BBR VT CONA CMX post-tensioning technologies, all of which are now available on YouTube.

SUPPLY CHAIN UPDATES

Josef Lamprecht and Marco Corti brought delegates up-to-speed with the latest news on production, quality control and global supply chain. This section of the Webinar included a review of how the BBR global supply chain has been optimized in recent years, as well as how the BBR E-Trace online trading platform continues to facilitate online ordering and factory production control.

GEOTECHNICAL BUSINESS UPDATES

An in depth review of all aspects of the BBR geotechnical business line was presented by Cezary Sternicki. Market information was shared and comparisons offered with market sectors for other BBR technologies. The presentation also addressed the unique value propositions of BBR GT technologies which BBR Network Members can leverage to secure opportunities not only to increase their business – but also to extend the service they provide to their customers.

R&D UPDATES

Technology presentations from the R&D team began with Dr. Haifeng Fan who gave an overview of aspects of the HiAm CONA stay cable system and CONA CMX post-tensioning systems, along with details of the new developments currently in the pipeline. This was followed by a session with Dr. Xiaomeng Wang who highlighted aspects of the BBR VT CONA CMG strand ground anchor and BBR Bar systems, as well as sharing news of developments underway in this market segment.

News Highlights Achievements from around the BBR Network

A year to remember?

Most definitely! In spite of being the most challenging time that the world has faced for years, the last 12 months saw many positive developments within the BBR Network and a determination to continue the strong culture of information sharing via the digital world. There have been reasons to celebrate and many new additions to the marketing and communications toolbox. All of these elements place the BBR Network in a great position as the global economy returns to a more familiar pace and shape.

MARKET LEADER EXPANDS INTO NEW TERRITORIES

Since joining the BBR Network three years ago, BBR Saudi Arabia has achieved huge growth for their business which has propelled them into the market leading position locally. This major achievement is underpinned by their specialist skills in devising alternative solutions using post-tensioning to optimize construction projects – and ultimately delivering significant cost savings for their customers. Their reputation for implementing many innovative and sound technical solutions which enhance productivity on site as well as achieving complex architectural requirements has grown through their work for a number of recent landmark projects including the Arar Museum, Ajdan Rise residential development and Al Moussa Hospital. Meanwhile, with the recent creation of BBR Bahrain and BBR Oman, the company is actively pursuing business development activities in these two new territories and we look forward to reporting similar successes in future editions of CONNÆCT.

BBR PT SPECIALIST TRAINING GOES VIRTUAL

Over consecutive days last October, BBR HQ ran a successful training event in an online format – the BBR Network Training Series. It was a busy but well organized training schedule – three sessions on three different days, covering BBR post-tensioning, geotechnical and stay cable technologies, plus the robust BBR Quality Assurance program to welcome newcomers or refresh the knowledge of existing BBR Network Members. This all added up to a total of over six hours of training during which the BBR HQ team presented all the ranges within BBR's technology portfolio, as well as many exciting design and detailing aspects.

GOING VIRAL

Among the many regular postings on the BBR Network LinkedIn page was a short video of the axial testing to *fib* Bulletin 89 criteria of a massive 91-strand BBR stay cable. Not only did the stay cable successfully blast through the testing, but the number of 'views' and 'likes' reached an all-time high too! Meanwhile, the BBR HQ team has ensured a continuous flow of interesting messages and information – including a major series of posts showing how the BBR VT CONA CMG strand ground anchor system is a true market disrupter. Visit the BBR Network LinkedIn page to catch up with all the details.

SEVENTY-FIVE YEARS OF STAHLTON

In 2020, Stahlton AG, the BBR Network Member for Switzerland, celebrated the 75th Anniversary of the company's founding back in 1945. The company's history stretches back almost to the roots of BBR itself and its experience and expertise in specialist construction engineering remains at the leading edge. Congratulations to the whole team – and best wishes for the next 75 years!

FRANCHISE VISIT TO PHILIPPINES

Before the imposition of travel and hygiene restrictions related to the Covid-19 coronavirus, BBR VT International Deputy CEO Cezary Sternicki paid a visit to the Philippines. The main purpose of his trip was to advise on stressing procedures for the BBR H Bars being installed on the Santa Monica-Lawton Bridge in Manila. Taking full advantage of the opportunity, meetings were also arranged with local contractors who were interested in BBR technologies. It was a great opportunity to strengthen the BBR brand locally by presenting the BBR Network in general and hosting discussions about new and upcoming technologies, as well as listening to feedback from end-users and customers. Since this very memorable and productive visit, Marco Zucconi and Daniel Cuerdo, from the BBR Business Development team, carried out a virtual franchise visit to the Philippines – one of many such 'visits' providing support by video call or with webinars to BBR Network Members over recent months.

NEW LOOK, NEW FEEL & NEW WAYS TO SAY 'POST-TENSIONING'

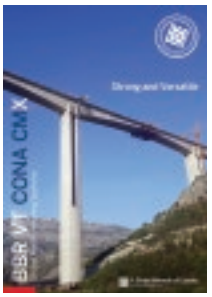
The BBR Network website was optimized for mobile devices over recent months – and also includes a refreshed design. Meanwhile, software was upgraded to ensure security and compatibility of features and functionality. As well as being mobile-friendly and featuring an updated design, multiple language options are also available – the new website can now be explored in English, French, German or Spanish.

LIGHTS, CAMERA – ACTION!

The BBR Network movie factory has been in action again. First there was the 2020 BBR Network Highlights video which presents a brief overview of some of the great achievements with BBR technology and techniques from around the globe during the previous 12 months. Then came the world première of the latest BBR Technical Series video which showcases key features of the European assessed BBR VT CONA CMB post-tensioning system, widely used for the prestressing of wind towers and also for strengthening of railway and road bridges. Both videos have been released on the BBR Network YouTube Channel, so why not pull up a chair and take a look?

DOUBLE ANNIVERSARY IN AUSTRALIA

This year, 2021, marks two major milestones in BBR history. The first was the establishment, prompted by rock anchoring contracts for the massive Snowy Mountains Hydro Scheme, of BBR Australia (now SRG Global) back in 1961. Twenty years later, the second was the opening in 1981 of Sydney Tower constructed with the innovative application of BBR stay cables. We offer our best wishes and congratulations to all at BBR Network Member SRG Global for an exciting anniversary year with yet more pioneering projects using latest BBR technologies.



HOT OFF THE PRESSES

The major publication launched in the last 12 months was a highly comprehensive new brochure covering the whole of the BBR VT CONA CMX post-tensioning range. The brochure includes the newest additions to the family – such as CONA CMM S2, CONA CMF S2, CONA CMI EIT and all the new applications for CONA CME – as well as commercial and technical details. There's a wealth of information about the uses of post-tensioning, international certifications, design detailing and a section covering technical specifications – and much more. Also, the BBR Plastic Ducts brochure and the whole range of BBR technology flyers were revised and updated respectively. All are now available for download from the BBR Network website or on request from your nearest BBR Network Member.

BBR Awards 2020 Outstanding achievements by BBR Network Members

Awards for excellence

The BBR Awards, an extra-special highlight in the BBR calendar, are presented to BBR Network Members who have achieved outstanding performance during the past year. All awards recognize excellence in innovation, engineering and customer service which reflects on the entire BBR Network globally.

BBR PROJECT OF THE YEAR 2020

The ultimate accolade is the BBR Project of the Year Award. An international panel of judges reviews a shortlist of up to six projects each year to decide the winner. Projects are selected based on three main criteria – technical challenge, innovation and scope of service offering – all of which, of course, have a strong focus on customer satisfaction.

The BBR Project of the Year 2020 Award was presented for strengthening work on the Echinghen Viaduct in France. The innovation applied to this project, by French BBR Network Member ÆVIA, showed not only the excellence of BBR technology for infrastructure retrofit schemes, but also the deep technical skills available within the BBR Network.

The Runner-Up was Keepit Dam – a dam strengthening project where Australian BBR Network Member SRG Global yet again installed world record-sized BBR ground anchors. Meanwhile, another SRG Global scheme – the Al Zour LNG Import Project in Kuwait – involving the installation of BBR cryogenic post-tensioning for an amazing total of eight new LNG storage tanks won a 'Highly Commended' citation.

MANY CONGRATULATIONS TO ALL BBR AWARD WINNERS!

The whole team here at ÆVIA was delighted that their work at Echinghen Viaduct to replace the post-tensioning system with BBR VT CONA CME tendons was recognized with the BBR Project of the Year Award. As construction engineering specialists, we are constantly innovating to satisfy customer requirements – however, this was an exceptionally challenging project, both in terms of the technical demands and the exposed working location.

Mathias Kaminski, Director, ÆVIA Products, France

BBR CONNÆCT BEST ARTICLE AWARD

BBR CONNÆCT BEST PHOTOGRAPHY AWARD

2020 BBR Award Winners

BBR PROJECT OF THE YEAR 2020

Echinghen Viaduct, France – successful replacement of existing post-tensioning tendons with latest BBR technology was driven by significant innovation from French BBR Network Member ÆVIA.

BBR CONNÆCT BEST ARTICLE AWARD

Joint Winner: SRG Global (Australia)
Title: Talent for increasing productivity (Windsor Bridge, Australia)

Joint Winner: BBR Philippines Corporation (Philippines)
Title: River crossing with latest BBR technology (Santa Monica-Lawton Bridge, Philippines)

Highly Commended: BBR Construction Systems (Malaysia)
Title: Technical expertise overcomes challenges (KVMRT2)

BBR CONNÆCT BEST PHOTOGRAPHY AWARD

Winner: Kappa (Turkey)
Title: Automating the construction process (MSS Technology)

Runner-up: SRG Global (Australia)
Title: World record capacity anchors (Keepit Dam, Australia)

Highly Commended: BBR Construction Systems (Singapore)
Title: Shaping the Singapore skyline (High rise projects)

More about
BBR Project of the Year

Tana Bridge, Norway CONA CMI for back stay support

Bridge for all seasons

In the most northern region of Norway, construction of the new Tana Bridge has now been completed. Stig Solbjør of BBR Network Member KB Spennteknikk AS narrates this stunning photographic account of bridge construction through some of the world's harshest weather conditions.

This image taken in December 2018 shows the new Tana Bridge taking shape amid the arctic conditions of northern Norway.

1

14 December

This image shows the new Tana Bridge with its single 95m high asymmetrical pylon complete and some of the steel deck sections in place. The town of Tana Bru lies in Finnmark County within the Arctic Circle and for around two months each winter, there is no sun here. The landscape is lit only by the brightness of the white snow as it reflects the light. Additional artificial lighting allowed work to continue on site.

2018

4

04 September

The last back stay cable is attached to the 'ballast box' which forms the abutment on the western banks of the River Tana. Below the bridge deck, another steel deck section is ready for launching. In the foreground, the rails used for manoeuvring the deck sections can be seen.

5

16 September

The last bridge section has been moved under the bridge beam and is ready to begin its journey to complete the deck. Meanwhile, the rail system on the shoreline is being dismantled.

2

12 March

Here, the bridge is continuing to take shape and work progresses even while there is still snow and ice all around. A new 15m bridge section is being positioned and three back stays have been connected to the 'ballast box' where they are secured by BBR VT CONA CMI post-tensioning tendons.

2019

3

15 July

This is a close-up of a new deck section being attached to the hoist at the end of the bridge beam. The 11 bridge deck sections – each weighing around 125t – were launched beneath the bridge, lifted by the hoist device into their final positions and then welded into place.

6

01 October

As autumn starts to give way to winter, the last bridge section is being hoisted up to be level with the bridge beam. Elsewhere on the site, roadworks are being completed to link the bridge with the E6 highway.

7

02 June

A detailed view of the ballast box shows that all of the back stays have now been installed and secured. KB Spennteknikk produced and preassembled 36 BBR VT CONA CMI internal post-tensioning tendons. These were installed vertically in the ballast box to secure the back stays. The tendons were installed, completely preassembled, with an inaccessible passive anchor in the bottom slab before concreting the ballast box.

2020

8

28 August

Here's an aerial view of the completed Tana Bridge, 100m upstream from the old Tana Bridge. The crossing at Tana Bru is the only one for 100km on the lower reaches of the river. The new two lane E6 bridge was built to alleviate occasional congestion and to replace the soon to be demolished older and smaller structure.

9

15 September

Registered in August 1947, this Chevrolet van was the first vehicle to drive over the old Tana Bridge when it opened in August 1948 – and was also the first to cross the new Tana Bridge on September 15, 2020. As well as a cavalcade across the bridge, the opening ceremony included official speeches, traditional Sami singing and a wonderful light show provided by the bridge's own state-of-the-art digital lighting installation.

10

27 September

This is a night-time view of the new Tana Bridge with its 234m main span across the Tana – Norway's largest salmon river. While the casual observer will easily appreciate the architectural elegance of this new structure, what they will not see is one of the fundamental reasons for its great strength. The 36 CONA CMI internal post-tensioning tendons which transfer the structural loads of the bridge are completely hidden in the concrete ballast box behind the pylon.
These 10 fabulous photographs were chosen from a huge collection made available by talented amateur photographer Frank Martin Ingilæ, the former Mayor of Tana Bru. We are grateful to him not only for allowing us to share these superb images with other BBR Network Members and the international engineering community, but also for his great enthusiasm for the project which has inspired such a magnificent result for the local community, the contracting team and their client, Statens Vegvesen.

TEAM & TECHNOLOGY

Owner – Statens Vegvesen
Main contractor – Vistal Gdynia SA + HAK Entreprenør AS
Technology – BBR VT CONA CMI internal, Pot bearings, PT bars, Expansion joints
BBR Network Member – KB Spennteknikk AS (Norway)

Chinegga Bridge, Stalden, Switzerland CONA CMI internal post-tensioning for bridge deck

Alpine bridge for bypass

The new H212 local road was constructed to give access to the world famous resort of Zermatt while bypassing Stalden and relieving the village center from traffic. The topography of the area meant that around two thirds of the route had to be created using special structures, such as covered cuttings, galleries, tunnels, bridges, viaducts or leaning viaducts.

The main 270m-long Chinegga Bridge stretches in a wide bend, some 60m above the Mattervispa Valley. The bridge was constructed as a post-tensioned concrete box girder, resting on five supports. Swiss BBR Network Member Stahlton installed a total length of 2,560m of BBR VT CONA CMI internal 2706 tendons for the post-tensioning, using 40 movable and 16 fixed couplers. The bridge deck was built using 4,300m³ of in-situ concrete, 690t of reinforcement and 83t of prestressing steel.

TEAM & TECHNOLOGY

Owner/client – Kanton Wallis/Canton Valais
Main contractor – Ulrich Imboden AG
Engineer – Schneller Ritz + Partner
Technology – BBR VT CONA CMI internal
BBR Network Member – Stahlton AG (Switzerland)

With a deck realized using BBR VT CONA CMI internal tendons, the 270m-long Chinegga Bridge stretches in a wide bend, some 60m above the Mattervispa Valley.

Visualization of the new Infinity Bridge in Dubai which features a 42m high arch, shaped like the mathematical symbol for infinity.

Infinity Bridge, Dubai Specialist PT & balanced cantilever construction

Infinitely iconic

A unique bridge is taking shape in Dubai and is set to create yet another architectural icon for the Emirate. Mark Martin of BBR Network Member, SRG Global describes the scheme and outlines his company's work on this stunning project.

The new bridge is under construction as part of the Al Shindagha Corridor Improvement. The scheme covers some 13km of roads and is focused on mitigating the foreseen increase of congestion at the Sana Junction thus improving connectivity in central Dubai. The new bridge will replace the 40-year old Shindagha Tunnel that currently connects Al Ras in Deira and Al Shindagha in Bur Dubai and also provide connections between new projects currently in progress, such as Deira Islands, Dubai Water Front, Rashid Port and Dubai Maritime City.

Bridge design

The 295m bridge will rise 15.5m above Dubai Creek to allow clearance for shipping. It will carry six lanes of traffic in each direction and a segregated steel walkway for pedestrians. The bridge's iconic design features a 42m-high arch shaped in the form of the mathematical symbol for infinity. Approximately 2,400t of steel will be used in the construction of the bridge.

The Road and Transport Authority in Dubai appointed Belhasa Six Construct LLC (Besix) as the infrastructure contractor in 2018 and the project is expected to be completed in 2021. In turn, SRG Global were awarded the specialist engineering and construction contract for the bridge by Besix.

Scope of works

Our scope of works includes provision of full post-tensioning supply and installation, as well as providing our expertise for the delivery, erection and operation of specialist formwork travelers for the construction of the main bridge deck using the balanced cantilever method.

The use of post-tensioning for the bridge allows for long clear spans and a highly creative architectural approach. The project design involves 852t of 15.2mm steel strands and 1,536 BBR VT CONA CMI internal anchorages for the 1206 and 1906 tendons.

The method requires two stressing stages. The first involves stressing of the top slab cantilever tendons after casting each 3m segment of the box girders and the second involves stressing of the top and bottom slab tendons after completion and joining of the whole span.

Formwork travelers

We are providing design, fabrication and operation of 16 sets of formwork travelers – or form travelers – for the project. As many readers will know, form travelers are a specialist method of bridge construction whereby segments of the bridge deck are progressively cast in-situ, with the formwork supported on the section of works already cast and cured. After each segment, post-tensioning tendons are stressed and the formwork is then launched forwards hydraulically into the next position, ready for casting of another segment. The unique challenge on this project is the number of form travelers being operated concurrently to allow all four box girders to be built from both sides of the river simultaneously. Balanced cantilever construction using form travelers is particularly effective over bodies of water, live traffic or indeed sensitive landscapes, as it leaves them undisturbed while construction progresses overhead.

TEAM & TECHNOLOGY

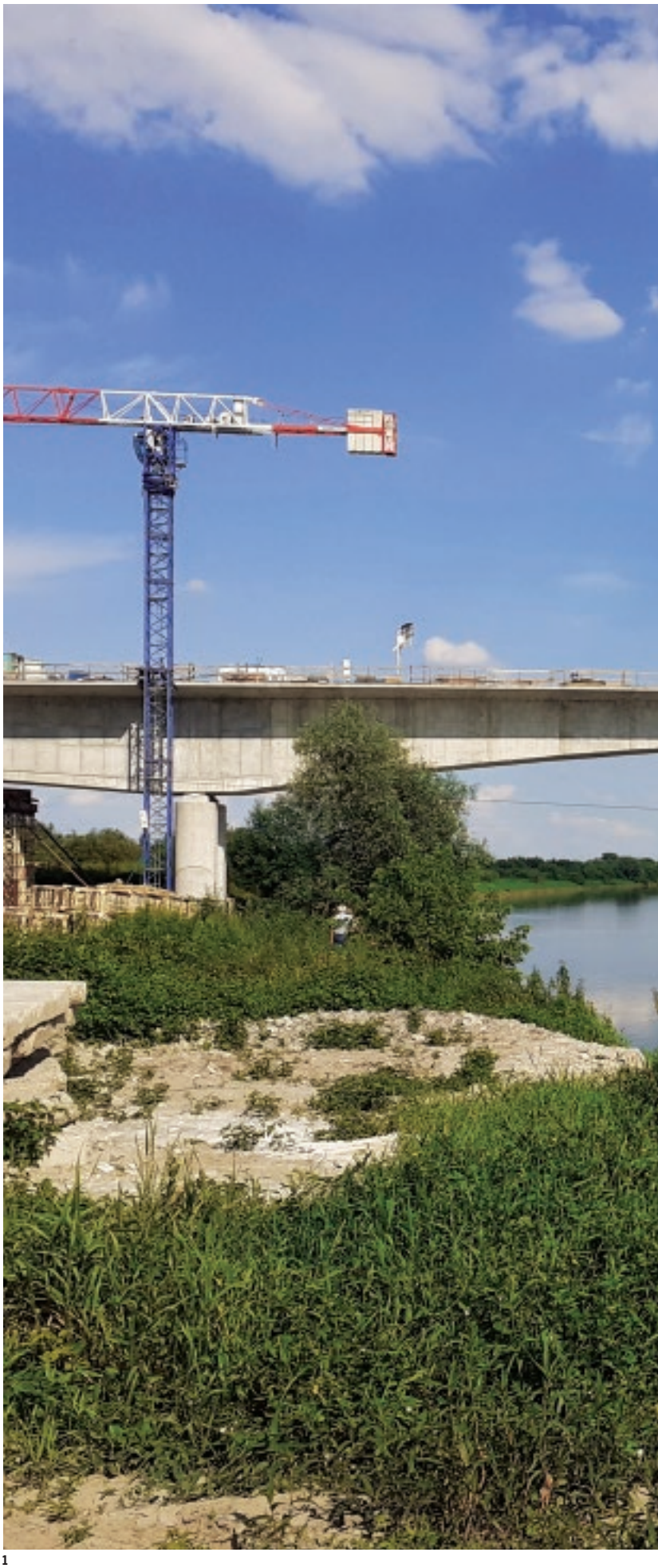
Owner – Roads and Transport Authority
Design & build contractor – Belhasa Six Construct LLC (Besix)
Technology – BBR VT CONA CMI internal, Balanced cantilever, Form travelers
BBR Network Member – SRG Global (Middle East)

Borusowa-Nowy Korczyn Bridge, Poland
Form-traveler & BBR post-tensioning technology

High productivity for new bridge

Covering a distance of over 1,000km, the River Vistula is Poland's longest river. It passes through all of the country's largest cities and is deeply embedded not only in the culture of the land, but also in the history of BBR Polska. Most recently, the team has been delivering form-traveler and post-tensioning services for a new bridge across the river in southern Poland, Tomasz Jendernal, CEO of BBR Polska takes up the story.

Over the past 20 years, we have spent many hours working above the waters of the River Vistula. We have been delighted to provide specialist construction services for 13 wonderful new bridges – as well as for the rehabilitation of a further five bridges. This has taken our teams on a journey almost right from the river's source to its delta on the Baltic coastline. ›



1

Project overview

Now, our latest bridge project stretches across the waterway for more than 670m. It connects the two communities of Nowy Korczyn and Borusowa, while also facilitating access to the city of Tarnow and the A4 motorway. However, this is not the first crossing at this location – a bridge was completed in 1939 and blown up just a few weeks later in an attempt to stop invading forces advancing during World War II. Since 1945, a local ferry service has been taking people and vehicles back-and-forth across the Vistula.

The new PLN 54 million bridge scheme involved construction of the main box girder span using form travelers – which we designed, supplied and operated – as well as providing and installing BBR VT CONA CMI internal and CONA CME external post-tensioning.

2

3

Construction techniques

This new 12-span bridge was constructed using a combination of techniques – incremental launching for nine spans, full scaffold for two spans and free cantilevering for the longest span of 130m, across the river, which was achieved using a pair of our own form travelers. BBR Polska's form traveler concept was developed on our first free cantilevering project back in 1998 – the Northern Bypass Bridge in Opole – and has continued to be refined and further developed for each new project.

The bridge features both BBR VT CONA CMI internal 1206, 1906, 2206 and also CONA CME external 3106 tendons. CONA CMI tendons were installed in the top slabs to provide stability during cantilever construction. Further CONA CMI, as well as CONA CME, tendons were installed and stressed after the superstructure was fully completed.

High productivity

The design and build project was carried out for regular customer Intercor who had chosen the prestressed, continuous box girder design with the free cantilevered main span as a cost- and time-effective solution.

Productivity on the project was excellent, with the team achieving a one week cycle time for typical segments – and at the peak of the project, we were achieving three segments every two weeks.

The success of the project was due to a number of factors – proven form traveler construction, a highly experienced team and latest technology, as well as the advantage of working alongside a main contractor with

whom we have worked many times before. In fact, our strong working relationship with Intercor has been built over several similar projects – most notably the balanced cantilever bridges at Nowy Sacz and Bydgoszcz. Even earlier, we also worked together on the stunning Father Laetus Bernatek footbridge in Krakow (see adjacent article) which, along with Warsaw's Temple of Divine Providence, was awarded the BBR Network Project of the Year back in 2011. As one of Poland's largest construction sites, many people came to watch as work on the bridge progressed. Our site team appreciated their support – and were glad to be able to share the excitement that the creation of a new bridge inspires.

4

1 The new bridge over the River Vistula at Borusowa was created using BBR post-tensioning technologies and BBR Polska's expertize with form travelers.
2 A combination of techniques were used to construct the bridge – incremental launching, full scaffold and free cantilevering. Pictured here is the completed bridge and dismantling of the form travelers is underway.
3 BBR VT CONA CMI tendons were installed in the top slabs to provide stability during cantilever construction. Further CONA CMI and CONA CME tendons were installed and stressed after the superstructure was fully completed.
4 Close-up view of construction as span closure approaches.

TEAM & TECHNOLOGY

Owner – Zarząd Dróg Wojewódzkich w Krakowie
Architect/consulting engineer – Zakład Usługowo-Projektowy MOSTEX Tadeusz Stefanowski
Main contractor – Intercor Sp. z o.o.
Technology – BBR VT CONA CMI internal, BBR VT CONA CME external, Free cantilever construction, Form traveler
BBR Network Member – BBR Polska Sp. z o.o. (Poland)

Bridge at heart of community

The Father Laetus Bernatek Bridge in Krakow has just celebrated its 10th anniversary. When the BBR Polska team, along with their colleagues from Intercor, constructed and installed this structure back in 2010, they could not have imagined just how much the community would embrace this iconic pedestrian and bicycle bridge.

The bridge consists of two decks curving outwards from a central steel arch spanning 146m which is tied with BBR VT CONA CME external post-tensioning tendons. The complex construction project involved a carefully monitored rotation manoeuver to place the bridge in its final location. You can read the full story of construction work on page 31 of CONNÆCT 2011.

Officially opened in September 2010, over the past decade this bridge has developed a life and personality of its own. In 2017, the cables tying down the arch were adorned with nine sculptures of acrobats cast in bronze resin by artist Jerzy Kędziora. The sculptor is internationally acclaimed for his many gravity defying sculptures which he describes as "half-balancing on the edge of imagination".

Meanwhile, the bridge has unofficially become known as 'Lovers Bridge' because of the many padlocks installed there by couples who then throw the keys into the River Vistula below as a symbol that their love will be forever.

The Father Bernatek Bridge has not only inspired local people – and at least one artist – to take it literally to their hearts, but it also evokes memories of a fulfilling and enjoyable construction project among those who worked on its realization.

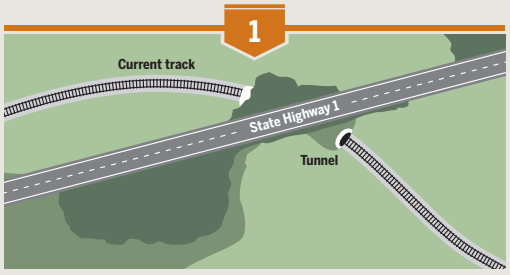
KiwiRail Bridge, South Island, New Zealand PT for railway overpass bridge

All change for rail-road resilience

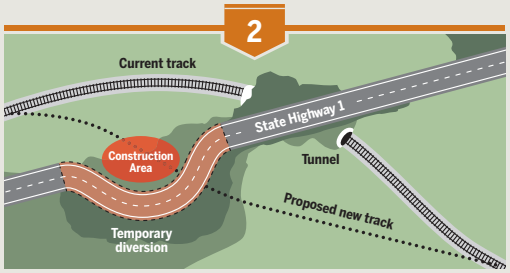
If you've ever traveled on the Coastal Pacific – the long-distance passenger train that runs between Picton and Christchurch in New Zealand's South Island – you'll know that it's well deserving of its place as one of the most picturesque train journeys in the world. You might also have noticed a drop in speed, while going through a tunnel just south of the small town of Ward, and not known there was a 100-year-old story behind it. With the help of BBR Contech, we can now reveal some of the history, as well as offering a glimpse into a fascinating project.

1

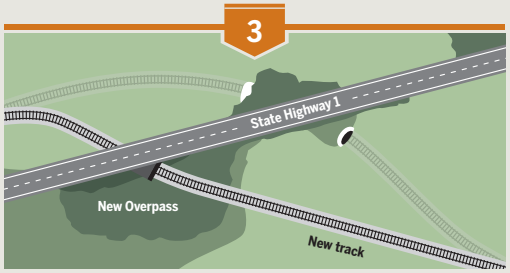
Step-by-Step Guide



Before works began



During construction



After completion

2

3

Project history

The tunnel was called KiwiRail Tunnel 21, and for unknown reasons sometimes also the Tar Barrel. It was built in 1913 during the 1870s-1945 'Golden Age' of railways, and extended for 167m through mudstone rock.

By the 1970s, Tunnel 21 was the oldest tunnel on the Main North Line and its concrete lining was starting to crack – a situation made worse in 2016 with the 7.8-magnitude Kaikōura earthquake. While repairs kept the tunnel operating safely, its long-term future was looking bleak – especially as its small size meant trains had to reduce speed to 25km per hour to travel through it. As they say, time is money and this flaw was affecting journey times on – and the efficiency of – a key route for freight movements between Auckland and Christchurch.

Seismically strong solution

In 2018, KiwiRail, the owner and operator of New Zealand's rail network, decided it was time to decommission Tunnel 21 to improve rail operations and strengthen the railway's seismic performance. In a NZ$35m project, the railway was to be re-routed away from Tunnel 21 and a new 100m-long road overpass – to carry traffic on State Highway 1 – would be built across the tracks. Trains would be able to travel under the overpass at up to 80km per hour and the risks posed by the ageing tunnel to the road and rail networks would be eliminated.

PT tendon installation

So, where is BBR Contech in all this? HEB Construction sub-contracted BBR Contech to execute the post-tensioning work. The latter involves the installation and stressing of 15 BBR VT CONA CMI 406 internal multi-strand tendons – each 33-34m long – which stretch through the overpass's 82 double-hollow-core precast beams in three stages. Project completion is due in mid-2021.

Interestingly, the 500,000m^3 of excavated spoil has not been taken off site – it will be used as part of a landscaping program that includes two hectares of native plants. This project offers a great result for all stakeholders!

1 The overpass is being constructed with 82 double-hollow-core precast beams.
2 Diagrams showing the site of the new highway overpass and re-routing of the railway tracks away from KiwiRail Tunnel 21.
3 The team installed 15 CONA CMI internal post-tensioning tendons in the new overpass.

TEAM & TECHNOLOGY

Client – KiwiRail Holdings
Main contractor – HEB Construction
Structural engineer – Tonkin + Taylor & Holmes Consulting Group
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Contech (New Zealand)

BBR Malaysia proposed an alternative post-tensioning installation solution for the two beams being constructed for the overhead Taman Putra Permai Station on the Line 2 of the Klang Valley MRT Project.

Station Beams, KVMRT, Malaysia Alternative solution with CONA CMI

Embracing change saves time

Taman Putra Permai Station is one of 27 elevated stations being constructed as part of the Klang Valley MRT Project's second line, namely the Putrajaya Line. After unforeseen issues had badly affected the station's construction progress, BBR Malaysia was brought on board the project and their alternative solution delivered the required results – ahead of schedule.

To expedite the station's remaining works, construction sequences and planned schedules had to be revisited. Having established a strong track record in previous MRT packages, BBR Malaysia was hired to provide input on the construction method and propose an alternative solution for the post-tensioning work sequence.

Post-tensioning work

The post-tensioning works involved the installation of eight 1906 BBR VT CONA CMI internal tendons, each of them 123m long each, in a twin spine beam of 900mm width x 1500mm depth. There were four tendons in each beam. The tendons had seven inflection points and were to be stressed from both ends. Due to the exceptionally long tendon length and multiple high and low points, installation of strands posed a major challenge.

Benefit of experience

Earlier, the BBR team had been involved in the construction of an identical station. Dictated by the construction sequence adopted by the contractor, installation of strands could only be done later – after concreting the whole beam. Empty ducts were first installed according to the tendon profile, followed by the concreting of the beam and platform concourse slab. After the last zone had been concreted and the concrete had set, the side formwork was removed. Soon after, strand installation followed and was achieved by a combination of push and pull-through methods, strand-by-strand. However, as the ducts were progressively filled with more strand, space within the duct became ever tighter making strand pushing or pulling really difficult – resulting in a delay to the overall tendon installation process.

With this experience in mind, BBR Malaysia took an unconventional approach to installing the tendons for this station. Preliminary discussions were held with the contractor and the client, recommending that they should alter their usual construction sequence, which would have otherwise resulted in the same problem. After many rounds of discussion and brainstorming, they agreed to BBR's proposal with slight hesitation.

Completion ahead of schedule

First, the reinforcement cage for the full length of the beam was tied up. As the reinforcement cage for the beam was progressively tied, the empty tendon ducts were continuously coupled and laid horizontally on temporary profiling bars. This allowed for seamless insertion of the strands without 'tangling', which would have occurred due to the multiple inflection points. After all the strands were installed, the tendons were gradually lowered down using chain blocks onto the permanent profile bars and the beams were ready to cast. In summary, the whole tendon installation works were completed in approximately one week, faster than expected, avoiding further delay and accelerating the overall construction program for the station.

TEAM & TECHNOLOGY

Owner/developer – MRT Corporation Sdn Bhd
Main contractor – Trans Resources Corporation Sdn Bhd
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Construction Systems (M) Sdn Bhd (Malaysia)

E39 Bridges, Rossevann, Norway
Incremental launching & BBR VT CONA CMI post-tensioning

Combined package for green construction

Infrastructure development in Norway is running at an unprecedented pace and, on one of the current schemes, two BBR Network Members have joined forces to deliver a packaged specialist construction technology solution. Jacek Sowa of BBR Polska guides us through the Rossevann Bridge project on the E39 motorway.

It was back in 2019 when local BBR Network Member KB Spennteknikk AS brought a delegation from major Norwegian contractor Kruse Smith to Poland. They wanted to see our capabilities in action as the incremental launching bridge construction method has only seldom been used in Norway.
The contractor was looking for a single source for specialist engineering services, including post-tensioning and a construction methodology that minimized impacts on the environment. The new motorway needed to cross a sensitive area, part of the Rossevann Lake, an important drinking water source and natural habitat, located a few kilometers away from the city of Kristiansand in southern Norway.
After the visit to Warsaw, decisions were made quickly and progress on site last year was equally efficient. By early September 2020, the twin bridges carrying the new E39 motorway had been completed.
As CONNÆCT 2021 goes to print, work on a further pair of incrementally launched bridges at Monan is advancing – again, alongside our fellow BBR Network Member, KB Spennteknikk AS.

TEAM & TECHNOLOGY

Client – Nye Veier AS
Main contractor – AF Gruppen
Specialist subcontractor – Kruse Smith Entreprenør
Technology – BBR VT CONA CMI internal, Incremental launching, Pot bearings
BBR Network Member – BBR Polska Sp. z o.o. (Poland) + KB Spennteknikk AS (Norway)

Step-by-Step Guide

1

Here, the launching noses for both carriageways are in place and the third segment for the northern carriageway has just been launched hydraulically into position over Rossevann Lake. Casting for the second segment on the southern carriageway is still underway in the casting yard behind the launch site.

2

The 30m long third segments for both carriageways are now completed. BBR VT CONA CMI internal post-tensioning tendons were pre-installed in each segment, then once in position tendons were connected using K Couplers. Stressing was carried out two days after casting.

3

Launching of the fifth segment for the northern carriageway is in progress. During the operation the launching nose tip deflection was 170mm. The whole process took just 5.5 hours to complete. This was a milestone achievement because it meant that the longest span, of 60m, between the piers had literally been bridged.

4

Both carriageways have now been completed. Launching noses are being dismantled, ready to be transported to the Monan Bridge site, a few kilometers away, where they will begin their second journey. Meanwhile at Rossevann Bridge, the exchange of temporary bearings for permanent ones will start and finishing works will be completed on the twin carriageways.

New Māngere Pedestrian & Cycle Bridge, New Zealand Post-tensioning for bridge piers

Elegant addition to Auckland waterscape

A stunning new bridge in New Zealand is offering excitement and fresh challenges for the BBR Contech team. They are supplying and installing BBR VT CONA CMI internal post-tensioning for the piers of a new and dramatic bridge structure which promises to be so much more than just a crossing – it is set to become a destination in its own right.

Visit New Zealand's largest city and you'll soon discover it's often called the City of Sails, owing to its numerous yacht marinas and the sail-boats anchoring offshore. If you travel to-and-from the airport though, you might prefer to call it the City of Bridges as there are some glorious examples to be found along the route.

The newest bridge

The latest addition – currently under construction – is a shared walking, running, fishing and cycling bridge that will cross Manukau Harbour and connect the Auckland suburbs of Ōnehunga and Māngere Bridge. Strikingly elegant, it will replace the 'Old Māngere Bridge', a 250m-long, reinforced-concrete structure that opened as a vehicle bridge in 1915 and which itself was preceded by a single-lane timber bridge built in 1875. It has cultural significance too. Local iwi resided in the area as kaitiaki (guardians) of this important portage where waka (canoe) traveled from one coast to the other. Before the old bridge was built, it's said that crossings were possible on stepping stones at low tide.

Visualization of the new Māngere Bridge currently under construction with the help of BBR Contech – and, of course, the ever versatile, yet strong BBR VT CONA CMI internal post-tensioning system.

Community-focused design

A Waka Kotahi NZ Transport Agency project, the new bridge's design – which is the result of years of work with Mana Whenua (the Māori people that have an ancestral connection to the land), the community and other stakeholders – follows that of a traditional waka, and recognizes and celebrates the cultural and historical significance of the old bridge and the surrounding area.

The concrete bridge will be 300m long and feature a 60m central deck span and arch in structural steel, together with nine approach spans in reinforced concrete. The central deck span and arch are being fabricated in Napier (New Zealand). Designed to be a community meeting place, it will include benches so that people can relax and enjoy the views and there will be two fishing bays dedicated to those catching kai moana (seafood). It will also provide up to 6.5m of clearance underneath to allow waka and small watercraft to travel into the Upper Māngere Inlet. Where possible, parts of the old bridge will be salvaged and reused as artworks in the surrounding area, and cultural artwork will feature on the bridge structure and at the entry and exit points.

Construction methodology

To access the seabed, temporary 'cofferdam' structures, which create dams so that water can be pumped out to create completely dry working environments have been used. This set-up enables McConnell Dowell and the BBR Contech team to anchor a total of 32 prefabricated, 12-strand post-tensioning tendons in the concrete foundations at seabed level.

As each pier is constructed, the CONA CMI internal post-tensioning tendons are cast into the concrete pier elements. A steel plate is then fitted to the top of the concrete piers as part of the base of the steel arch structure. Then, using these steel plates as a bearing surface, the tendons are stressed – thus creating a seamless connection between the arch and foundations. The challenge then is to ensure that the tendons remain bone-dry for 10 weeks in this demanding marine environment, in preparation for post-tensioning.

To ensure the integrity of the arch and deck, they'll be coated with a zinc thermal metal spray with a sealer. An additional color coat will be applied to the visually exposed arch, with a protective anti-graffiti finish.

The BBR Contech team is thoroughly enjoying being part of this exciting project, which has attracted significant public interest. It's due for completion in 2022, and will no doubt attract visitors from far-and-wide – whether they simply want to cross the bridge or spend time appreciating and enjoying the environment.

As each pier is constructed, the CONA CMI internal post-tensioning tendons are cast into the concrete pier elements.

TEAM & TECHNOLOGY

Developer – Waka Kotahi NZ Transport Agency
Architect – Bossley Architects
Consulting engineer – Aurecon
Main contractor – McConnell Dowell
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Contech (New Zealand)

Bolivia Hill Upgrade, NSW, Australia Balanced cantilever construction

Improving road safety & efficiency

The New England Highway – Bolivia Hill Upgrade project is set to improve safety and efficiency levels for all users of this important freight corridor, which is also used as an alternative to the Pacific Highway. SRG Global, the BBR Network Member for Australia, were contracted by Transport for NSW (TfNSW) for the construction of this project.

1

The Bolivia Hill Upgrade project is located 35km south of Tenterfield in New South Wales. The project involves building over two kilometers of new road, a new 320m long bridge, wider lanes in each direction and widened road shoulders to improve safety.

The Australian and New South Wales Governments have committed funding for planning and building the upgrade of the New England Highway at Bolivia Hill. The works include construction of a balanced cantilever bridge, earthworks, pavements, storm water drainage, traffic and environmental management and landscaping. This scheme will improve safety for a known blackspot on the New England Highway, as two severe bends in the current road will be straightened by a new road and construction of the bridge.

Reducing environmental impact

A critical aspect of the project is to minimize the impact on the local environment so as to protect the endangered 'Bolivia Wattle'. This wattle tree, native to Australia and found only in this area of New South Wales, is classified as a vulnerable and endangered species. For this reason, an in-situ balanced cantilever approach was chosen in order to reduce the construction footprint and maximize the clear spans which are 150m at the center and 80m at the sides.

Due to the rugged and steep terrain the main pier for the bridge sits 30m above the ground and was built in situ. The columns consist of twin reinforced concrete blade walls which are connected at the top by the 8.55m deep post-tensioned hammer heads.

Steepest gradient

The traveling formwork system was specifically designed for the project and included a number of modifications which were required to suit the Bolivia Hill bridge. The bridge was designed on an 8% grade – the steepest gradient to be constructed by balanced cantilever in Australia. This resulted in a number of challenges that the construction teams needed to overcome. Additional heavy duty braking systems were designed to ensure the safe operation of the system along with removable and adjustable formwork systems to prevent clashing of the formwork with the mountainous terrain.

Internal & external post-tensioning

The single box girder segments are typically five meters in length and vary in depth from eight to six meters. Each segment is progressively post-tensioned to the previous segment and the pier hammer head using 22-strand BBR VT CONA CMI internal tendons. In order to reduce the weight of the typical segments, the concrete bottom slabs were reduced in thickness to 280mm through the addition of progressive 19-strand post-tensioning. These stressing operations are carried out prior to launching of the traveling formwork. Durability is a key concern for TfNSW, so all ducts are grouted once the stressing works are completed for each segment.

After the bridge concrete works have been concluded, the site team will install two 25-strand BBR VT CONA CME external continuity tendons along the complete 350m long bridge structure. These post-tensioning tendons will be housed in HDPE ducting which is fixed inside the box girder. Strand will be pushed into the ducting and the tendon will be stressed prior to being grouted and capped to ensure its 100-year design life.

Other works being undertaken on the project include construction of a retaining wall, construction of a temporary compound site to allow for a concrete batching plant, site office, laydown and stockpile areas, as well as the design, verification and construction of access tracks connecting the compound site to the bridge pier location via the valley floor. The project is due for completion in 2021.

2

1 Construction of the Bolivia Hill bridge, designed on an 8% grade – the steepest gradient to be constructed by balanced cantilever in Australia – resulted in a number of challenges that the construction teams successfully overcame.
2 Due to the rugged and steep terrain the main pier for the bridge sits 30m above the ground and was built in situ.

TEAM & TECHNOLOGY

Owner – Transport for NSW
Design & build contractor – Georgiou SRG Joint Venture
Structural engineer – Arcadis Australia Pacific Pty Limited
Technology – BBR VT CONA CMI internal, BBR VT CONA CME external, Balanced cantilever
BBR Network Member – SRG Global (Australia)

Highway interchange, La Réunion, Indian Ocean

Stressing in the sun

Thanks to the efficient and expert installation of BBR post-tensioning, a massive concrete pour – a record on the island of La Réunion – for a new highway interchange was achieved on schedule. Cédric Brunner of French BBR Network Member ÆVIA has shared some photographs and details of the project.

The beautiful island of La Réunion in the Indian Ocean is one of four overseas territories administered by France. Work is underway to construct the Nouvelle Route du Littoral (NRL), a coastal expressway which will link the island's two main urban centers of St Denis and La Possession, as well as forming part of the RN1 national road. When opened, it will replace the existing often congested coastal road which runs at the foot of cliffs and is exposed to risks from landslips and extreme weather conditions.

Post-tensioning work involved installation and stressing of 22 BBR VT CONA CMI internal 2706 tendons up to 110m long for a new interchange which will connect the NRL and the Barachois district of St Denis. This design allowed the achievement of a shape with variable inertia reaching 1.30m thickness in middle of the main span.

The viaduct forming the interchange is 112m long and 12m wide. During a huge 30-hour concrete pour over one weekend last September, some 200 mixer trucks delivered 1,400m^3 of concrete to complete the viaduct deck.

TEAM & TECHNOLOGY

Owner – Région Réunion
Main contractor – PICO
Technology – BBR VT CONA CMI internal
BBR Network Member – ÆVIA Câbles et Manutention (France)


Record PT
concrete pour

High-rise & multi-storey buildings, New Zealand PT approach for slabs

Elevated post-tensioning takes off in NZ

Three projects in New Zealand featuring elevated post-tensioned floors are now complete – and all are contributing to Auckland's built environment while also demonstrating the usefulness and value of elevated PT for multi-level commercial, residential and car park buildings. The specialist installation of BBR post-tensioning for all three projects was undertaken by BBR Contech, in partnership with its Australian counterpart SRG Global. The largest of these projects was the NZ$300m high-rise apartment tower, 'The Pacifica', in the heart of Auckland city. Marc Stewart, Business Development Manager at BBR Contech, shares the story behind the projects and reminds us of the advantages of taking a post-tensioned approach.

1

Post-tensioning was also used as part of the lateral load resisting system, with multi-strand tendons tensioned to 50% of their capacity to enable building flexibility during an earthquake event.

2

1 New Auckland landmark

With its 57 floors, The Pacifica rises 178m into the skyline and features boutique commercial space, a high-end restaurant, shops at street level and facilities including residents' lounges and a lap pool, sauna, steam room, spa, gym, media room, library and barbecue terrace. The 273 residential apartments are envisioned to be "the envy of many and the joy of few". Covering around 1,300m^2, the two level super penthouse at the top of the building is a landmark real estate offering.

The BBR Contech/SRG Global team's role in the creation of this amazing development was, working alongside main contractor Icon Co, to design, procure and install 55 post-tensioned floors in the complex.

The 1st to 7th floors span 1,000m^2 each and the 8th to 55th floors have 600m^2 spans. There was a full-time crew of three to five members on-site throughout the project. This largely reflected the challenging delivery timeframe – as well as the central CBD location, tight working environment, number of activities underway at the same time and the minimal space available for storage and loading.

For the first time in New Zealand, the team used a full-perimeter jump-form, encompassing all vertical tower elements. Electric jacks were used for climbing and the floors and post-tensioning installation works were constructed within perimeter screens hung from the jump-form. Post-tensioning was also used as part of the lateral load resisting system, with multi-strand tendons tensioned to 50% of their capacity to enable building flexibility during an earthquake event.

2 Firm deadline for AUT student accommodation

In 2020, the BBR Contech/SRG Global team was presented with an absolutely immovable deadline on a residential project for developer Cedar Pacific. Owing to burgeoning demand for purpose-built student accommodation close-by, Auckland University of Technology (AUT) had commissioned a two-tower residential development that had to be completed in time for the first semester of 2021.

The BBR Contech/SRG Global partnership leapt into action to install 33 elevated PT floors in the towers – one 17-storeys high, the other 18. We used BBR VT CONA CMF S2 flat post-tensioning tendons with one pour per floor which resulted in a total area of 14,078m^2.

The towers are located in the heart of the AUT campus and will be managed by specialist university housing property management company UniLodge. Together, they offer 641 self-catered studios for students, including an en-suite bathroom and kitchenette, as well as a king-single bed, wardrobe, desk, chair and bookshelf. The towers also include retail and hospitality services and student facilities such as fitness centers and a basketball court, plus a health and wellness center.

Of course we delivered on time, despite some terrible weather, the difficulty of finding people to do the job – as The Pacifica apartment project was underway at the same time – and the challenges of the Covid-19 coronavirus crisis. ›

3

3 City center hotel development

Last year was a busy one for elevated PT, with a third BBR Contech/SRG Global project also underway. This time, it was for the design and coordination of elevated PT floor installation in what had started as the Even Hotel then became Voco Auckland City Centre. Due to open in mid-2021, the hotel is on the corner of Albert and Wyndham Streets in Auckland's central business district, a space formerly occupied by the offices of the New Zealand Herald, the city's daily newspaper.

According to the Intercontinental Hotels Group (IHG), the decision behind the change of hotel followed the launch of their Voco brand, when "it became clear that the new brand would not... resonate with the colorful, unstuffy and laid-back Kiwi spirit" and a greater focus on sustainability was required. The hotel will have 200 rooms designed around the 'Me Time' concept, with premium beds, superior showers, innovative lighting and user-friendly technology, as well as an all-day restaurant and bar, plus a guest gym.

Voco Auckland City Centre will occupy the upper floors of the 37-storey building, with the lower floors housing the 294-room Holiday Inn Express Auckland City Centre. The two hotels will have separate entrances, but share facilities.

The BBR Contech/SRG Global team is working with Auckland's concrete construction and formwork specialist Marin Construction to complete the project, which will require a total of 21,562m^2 of elevated PT flooring.

By the time CONNÆCT 2021 goes to print, post-tensioning works will have been finished and Auckland's newest hotel development will be nearing completion, ready for opening in a few months' time.

1 The Pacifica: The Auckland skyline now has a new landmark structure – The Pacifica – which, along with two other recent major projects in the city, was realized with the application of BBR post-tensioning technology for the floor slabs.
2 AUT campus: The twin residential tower development for Auckland University of Technology features 33 suspended post-tensioned floors.
3 AUT campus: Pictured here during the early stages of construction are the twin jump-forms rising at the same time on the two residential towers, while post-tensioning layout work is underway in the foreground.
4 IHG Auckland hotels: When complete, a total of 21,562m^2 of elevated PT floor slabs will have will have been constructed by the BBR Contech/SRG Global specialists.

4

The BBR Contech/ SRG Global team is working ... to complete the project, which will require a total of 21,562m² of elevated PT flooring.

TEAM & TECHNOLOGY

1 THE PACIFICA

Developer – Hengyi Pacific
Architect– Plus Architecture
Main contractor – Icon Co Pty (NZ) Ltd
Technology – BBR CONA flat
BBR Network Members – BBR Contech (New Zealand) & SRG Global (Australia)

2 STUDENT ACCOMMODATION

Developer – Cedar Pacific
Architect – Marchese Partners
Main contractor – Icon Co Pty (NZ) Ltd
Technology – BBR VT CONA CMF flat
BBR Network Members – BBR Contech (New Zealand) & SRG Global (Australia)

3 VOCO AUCKLAND CITY CENTRE & HOLIDAY INN EXPRESS

Developer – Pro-Invest
Architect – SJB
Main contractor – Icon Co Pty (NZ) Ltd
Technology – BBR VT CONA CMF flat
BBR Network Members – BBR Contech (New Zealand) & SRG Global (Australia)

Advantages of elevated PT

Elevated post-tensioning, also known as post-tensioned suspended floor slabs, offers a number of significant competitive advantages – including program and budget savings – for all stakeholders in a property development. Full details of all aspects of post-tensioned floor slab construction can be found in the BBR PT Slabs brochure, available from the BBR Network website or your local BBR Network Member. Meanwhile, here's a quick overview of some of the key areas:

SHALLOWER SLABS

Elevated PT slabs are up to 30% shallower, reducing the building height or allowing more floors within the original building height while promoting faster installation times and saving money.

CONSTRUCTION SIMPLICITY

Elevated PT uses simple formwork and less materials than conventional methods – and requires fewer subcontractor trades. With elevated PT, beams are smaller and slabs are shallower offering savings in excavation and site preparation.

LARGE CLEAR SPANS

Elevated PT enables-large column-free spaces – spans of up to 15m are common. This creates more freedom in partition layout, flexibility for tenant-specific options – and potentially higher rental returns.

HIGH PERFORMANCE

Elevated PT slabs are more durable as they are highly-resistant to cracking, water seepage and deflections – thus, reducing lifecycle costs for building owners and operators.

DESIGN FLEXIBILITY

Elevated PT supports the achievement of complex geometries and special design challenges, meeting all the needs of modern architecture. With elevated PT, changes during – and alterations after – construction are possible while maintaining slab integrity.

REDUCED ENVIRONMENTAL IMPACTS

Elevated PT solutions require less materials than conventional methods, which translates into less embodied CO_2 and lower transportation impacts. Around four times stronger than conventional steel reinforcement, post-tensioned tendons require less steel and promote reduced concrete slab depths.

Visualization of the first-of-its-kind Timmac @ Kranji development in Singapore.

Timmac @ Kranji, Singapore Post-tensioning & pretensioning

First of a kind

Timmac @ Kranji is the first of its kind – a high-rise development catering for the needs of Singapore's small and medium enterprises (SMEs) in the metal, machinery and timber industries. Dickson Liew of local BBR Network Member, BBR Construction Systems Pte Ltd describes how they supplied specialist post-tensioning services for this ground-breaking project.

TEAM & TECHNOLOGY

Developer – JTC Corporation
Architect – ID Architects Pte Ltd
Main contractor – SH Design & Build Pte Ltd
Structural engineer – Mott Macdonald
Technology – BBR VT CONA CMI internal
BBR Network Member – BBR Construction Systems Pte Ltd (Singapore)

The multi-user Timmac facility is part of the Singapore Government's initiative to cluster SMEs of the same industry within a centralized location in a bid to boost collaboration and optimization usage of space.
Conceptualized in conjunction with the various relevant trade associations to ensure the scheme's ability to meet current and future operational needs, Timmac sits on almost six hectares of land and features two separate wings connected by a central ramp structure.

Dimensions & structural scheme

The timber wing has floor heights of seven meters and is designed to cater for loadings of up to 30kN/m^2, while the metal and machinery wing is designed for loadings of up to 50kN/m^2 with floor heights of 12m.
Given the size, required loadings and column spacing, a post-tensioned approach would normally be adopted to reap the benefits of slimmer concrete members and lower overall structure weight. In this case however, available floor heights did not necessitate usage of post-tensioning for the two wings. Instead, the structural scheme adopted for the timber wing and metal and machinery wing was a precast reinforced concrete beam and precast, pretensioned 'T' slab scheme. The central ramp structure needed a 14m wide ramp to accommodate heavy trailer loading and also to provide access to both wings of the development despite the difference in number of floors and floor heights. Thus, for this part of the development, a post-tensioned beam and slab system was adopted as the structural scheme.

Design challenges

BBR Construction Systems Pte Ltd (BBRCS) was involved in this project right from the initial schematic stage with the structural consultant, to the design and development stage and finally seeing it through to the tender and authority submission stages. The entire design process took over a year to get through the various stages. Several challenges were faced during the design stage as the expected loading was not typical of a factory or warehouse facility. In fact, we referred to highway road design manuals to ensure that our design adequately accommodated the much heavier loadings from the trailers and machinery.
The year spent on this collaborative design approach finally paid off when we were awarded the project for both the post-tensioning, as well as the on-site pretensioning work. BBRCS is proud to have successfully completed both workscopes which required installation of a total of 1,000t of prestressing steel for the post-tensioning work on the ramp structure and a further 600t for pretensioning work. It was perhaps appropriate that this unique, ground-breaking project was the first one for which we proposed, supplied and installed the BBR VT CONA CMI internal system.

Hotel Pical, Poreč, Croatia CONA CMM for longest cantilever

Largest all-year resort in Croatia

BBR Adria's project manager for the Hotel Pical project, Predrag Presečki, has every reason to be smiling. His team, which includes Dejan Buha, has just completed a superb new architectural feature that was only achievable with BBR's post-tensioning technology and expertise.

The Hotel Pical in Poreč, is currently being redeveloped as part of leading tourism company Valamar Riviera's €105m plan to create the largest year-round resort in Croatia. The transformation will result in a luxury 5-star beachfront hotel with 514 rooms, accommodating up to 1,700 guests, complete with conference and beach club facilities and a whole variety of extensively landscaped swimming pools – plus a different bar and restaurant for every day of the week!

Continued working relationship

Meanwhile for BBR Adria, this exciting project provided an opportunity to work once again alongside main contractor Kamgrad with whom they have worked many times before. At pre-contract stage, BBR Adria supplied engineering design services to the main contractor, along with buildability advice, for the distinctive 10m cantilever structure.

Construction overview

The cantilever structure features two accommodation floors above an open-air ground floor plaza concluding in an oval canopy which harmonizes with the upper storeys. Slab thicknesses vary from 30 to 80cm and incorporate shallow 80cm deep beams. The slab rests on 120cm diameter columns, with axial distances between them ranging from 11.2 to 19.4m. Both the beams and slabs were post-tensioned using the BBR VT CONA CMM system.

BBR Adria CEO Zelimir Bodiroga said: "We are immensely proud of our achievement of the longest cantilever ever yet constructed by the BBR Adria team. It proves conclusively that not only can sleek and attractive architectural visions be created using BBR post-tensioning, but also that we have the design and execution experience to deliver results which are truly Five Star!"

At the Hotel Pical site, BBR Adria's project manager Predrag Presečki and team-mate Dejan Buha in the background stand beside the hotel's newest architectural feature – only achievable with BBR post-tensioning technology and expertise.

Largest single investment

Scheduled to open for the 2021 season, this ambitious project represents the largest single investment in Croatian tourism. Many congratulations to BBR Adria for their excellent work – and best wishes to the Hotel Pical for a great season!

TEAM & TECHNOLOGY

Owner/developer – Valamar Riviera
Main contractor – Kamgrad d.o.o.
PT design – Konstrukta d.o.o., BBR Adria d.o.o.
Technology – BBR VT CONA CMM
BBR Network Members – BBR Adria d.o.o. (Croatia)

New Distribution Center, Auckland, New Zealand BBR VT CONA CMF flat PT

NZ's largest single-project floor slab

As New Zealand-based BBR Contech approach their three millionth square meter of post-tensioned floor slabs, Mike Lawson, Manager – Technical, Quality and Health & Safety, shares details of a record-breaking floor slab recently completed by the team and some further background to the story – which is all about food!

1

The BBR Contech team has just completed the largest floor slab ever produced in New Zealand in a single project. In terms of the scale of this amazing post-tensioning project, the adjacent statistics say it all.

The floor was installed as the foundation of a brand-new distribution center for Foodstuffs – a 100% New Zealand-owned company established in 1922 that's now the country's leading grocery distributor and one of its largest organizations.

State–of-the-art distribution

Foodstuffs operates through regional co-operatives that together run more than 700 owner-operated businesses. These include full-service supermarkets, retail food warehouses, neighborhood grocery stores, small convenience stores, large- and small-format liquor stores, fuel sites and specialist supermarkets that source goods from local growers and farmers.

Each regional cooperative supports and services its local stores through integrated warehouse and transport centers. These centers use a state-of-the-art 'voice picking' warehouse management system, which has enabled them to increase production, reduce repairs and maintenance and improve their health and safety records.

In February 2018, the company announced its intention to consolidate three of its North Island distribution centers into a single, purpose-built, temperature-controlled distribution center. Its chosen location was Auckland Airport's 'The Landing' – a world-class business park that comprises more than 100 hectares of development land catering for the logistics, technology and light industrial sectors. ›

In all there were 31 pours ranging from 300m³ to 530m³, with most slabs being 180mm thick.

2

Adding up the numbers

Since 1983, BBR Contech has delivered many square meters of post-tensioned floor slabs. The breakdown below shows the area of slabs they have constructed by industry sector.

SECTOR	m²
Logistics	874,867
Retail	637,664
Manufacturing	474,239
Dairy	446,700
Ports	123,600
Multi-use	55,300
Other	49,085
Transport	47,200
Residential	42,000
Healthcare	27,000
Agriculture	15,000
Civil	12,500
Accommodation	6,500
Office	5,000
Fisheries	3,760
Energy	3,500
TOTAL	**2,823,915**

TEAM & TECHNOLOGY

Developer – Auckland International Airport
Architect – Eclipse Architecture
Engineer – Day Consultants
Main contractor – Macrennie Commercial Construction
Technology – BBR VT CONA CMF flat
BBR Network Members – BBR Contech (New Zealand)

Early stage involvement

BBR Contech became involved with the Foodstuffs project in the early stages of its development, mainly in relation to the suitability and layout of the floor slab. However, the warehouse's design and layout later changed, making the original joint layout less than ideal. Working with Conslab – the concrete flooring contractor and an industry partner – BBR Contech redesigned the slab to minimize the number of armored floor movement joints and maximize the size of the floor pours. The originally specified floor joints were replaced with a patented joint system developed by Conslab in New Zealand that offers superior performance and durability. For Foodstuffs, this meant a robust and highly usable floor, low whole-of-life maintenance costs and enhanced operational efficiency.

The 74,000m² warehouse is approximately 360m by 230m at its most extreme dimensions – and overall the space equates to around the size of seven rugby football pitches. It uses two slab designs, as one area has a taller racking system than elsewhere and the floor is required to handle the heavier loads.

3

PROJECT STATISTICS

74,000m²
FLOOR SLAB

14,000
STRESSING OPERATIONS

13,000m³
CONCRETE

340,000m
STEEL PRESTRESSING STRAND

84,000m
DUCTING

Floor slab specifics

The floor comprises nine separate post-tensioned slabs of 6,000m² to 10,000m² in area, with heavy-duty movement joints around the perimeter. Each of the nine slabs comprises three or four smaller, continuous slabs with coupled tendons or stop-end joints.

Each slab was poured over two consecutive days. In all there were 31 pours ranging from 300m³ to 530m³, with most slabs being 180mm thick.

Given the size of the job, and working closely with Auckland Airport and main contractor Macrennie Commercial Construction, the BBR Contech team leapt into action to source materials and manpower. The latter was a particular challenge, as the project required a full-time crew of four to six members with the skills and experience to deliver a perfect result.

The whole thing went like clockwork. Our team was delighted to be working on this massive project, and we were very proud to emerge with an immaculate safety and quality record.

Latest BBR post-tensioning

The project signaled a new 'first' for BBR Contech with the use of the BBR VT CONA CMF S2 flat post-tensioning system. The system leads the market in offering all the benefits of a wide anchorage and coupler size range, with very thin slab depths and low reinforcement requirements, plus a very small minimum center spacing and slab thickness at low concrete strength.

It all adds up to smaller, lighter and stronger tendons for post-tensioning flat slabs – and at lower cost than previously. We had the confidence of knowing it had been rigorously tested – and were really pleased with the result.

4

Given the scale of the Foodstuffs post-tensioned floor, not to mention its place as one of the largest in the world and the requirement for it to withstand extremely heavy loads, the new CONA CMF S2 system is a welcome addition to the BBR range. The team is looking forward to using it for other projects – and perhaps adding to the tally of post-tensioned flooring undertaken for Foodstuffs, which now stands at a whopping 190,000m².

1 View of the whole Foodstuffs' new distribution center close to Auckland Airport, where BBR Contech installed a massive record-breaking 74,000m² post-tensioned floor slab.
2 Panoramic view during construction of the floor slab for Foodstuffs' new distribution center.
3 Even motor vehicles look minuscule next to the new Foodstuffs Distribution Center where the latest CONA CMF flat post-tensioning technology was installed to create the largest floor slab ever to be constructed in a single project in New Zealand.
4 Close up shot of one of the slab sections, with placement of the CONA CMF flat post-tensioning nearing completion.

Hilti Office Nord, Schaan, Liechtenstein BBR post-tensioning for new office building

Wide open plan work space

The vision for the new Hilti Office Nord building in Schaan was to create open plan working spaces using latest knowledge and catering for the digital requirements of the business in the future. Local BBR Network Member Stahlton has helped the client realize their vision by installing BBR post-tensioning to achieve the wide column-free spaces they needed to take their business forward.

This new development is located right next door to the Hilti Office Mitte building which was constructed the previous year. The Hilti Office Nord project has an imposing façade with a dark parapet and window bands, plus recessed areas which create reserved zones for the entrance and meeting rooms. The four storey building has room for 350 workstations – and thanks to BBRV flat post-tensioning, wide floor spans of up to 30 x 120m were possible to maximize daylight and working space. The team from Stahlton installed almost 500 fixed and 500 movable couplers, along with approaching 8,000m of prestressing steel for the tendons.

1 The Stahlton team installed BBRV post-tensioning to achieve the wide column-free spans needed to maximize daylight and working space.
2 The new Hilti Office Nord in Liechtenstein under construction.

TEAM & TECHNOLOGY

Owner/client – Hilti Aktiengesellschaft
Main contractor – Wilhelm Büchel AG
Engineer – Dr. Lüchinger + Meyer Bauingenieure
Technology – BBRV Wire
BBR Network Member – Stahlton AG (Switzerland)

1

2

1

Woodlands Health Campus, Singapore Showcase for benefits of BBR PT

Focused PT boosts performance

Scheduled to receive its first patients in 2022, the new Woodlands Health Campus (WHC) is a unique healthcare facility which incorporates new care models with design and medical planning. Singapore-based BBR Construction Systems (BBRCS) is providing expert post-tensioning services for the whole scope of the project.

Sited on 7.66 hectares of land with a built-up area of 246,000m², WHC will have both an acute and community hospital, a nursing home and specialist clinic. This will allow WHC to integrate a host of healthcare services, ranging from emergency to recovery and end-of-life care entirely within its own compound. WHC also boasts a 1.5 hectare garden specifically designed to encourage mental, emotional and physical convalescence for patients.

Construction packages

As it is such a large scale project, WHC was divided into three construction contracts. Contract 1 covers foundation work up to part of basement 1. Remaining superstructure work was split between Contracts 2 and 3. BBRCS was appointed as the PT specialist for all three contracts.

Focused PT approach

Despite having 10 buildings within this project, the post-tensioning proposed by the structural consultant has been mostly focused on areas requiring more stringent limits on serviceability and heavy loadings. This approach clearly showcases the benefits of using post-tensioning in reinforced concrete structures.

WHC has definitely not been without its complexities. Several sessions with the main contractor and structural consultant were needed to resolve the construction needs and various integration requirements for services and the building façade. Construction is now well underway and BBRCS is delighted to be engaged on this iconic project which will become a role model for healthcare provision.

1 Visualizations of the completed Woodlands Health Campus project which will feature BBR CONA internal post-tensioning in crucial locations where serviceability and heavy loadings are prime considerations.

TEAM & TECHNOLOGY

Developer – Ministry of Health Holdings/ Woodlands Integrated Health Campus

Architect – SAA Architects Pte Ltd

Main contractor – Contract 1: Penta-Ocean Construction Co. Ltd.
Contracts 2 & 3: Ssangyong + Daewoo + Koh Brothers (SDK) Consortium

Structural engineer – TY Lin International Pte Ltd

Technology – BBR CONA internal

BBR Network Member – BBR Construction Systems Pte Ltd (Singapore)

Delta Planet, Niš, Serbia BBR VT CONA CMM monostrand PT speeds construction

Exciting new retail destination

In spring 2020, the foundation stone for a huge new shopping mall was laid in Niš, Serbia where BBR Adria was contracted to support the development with specialist post-tensioning skills.

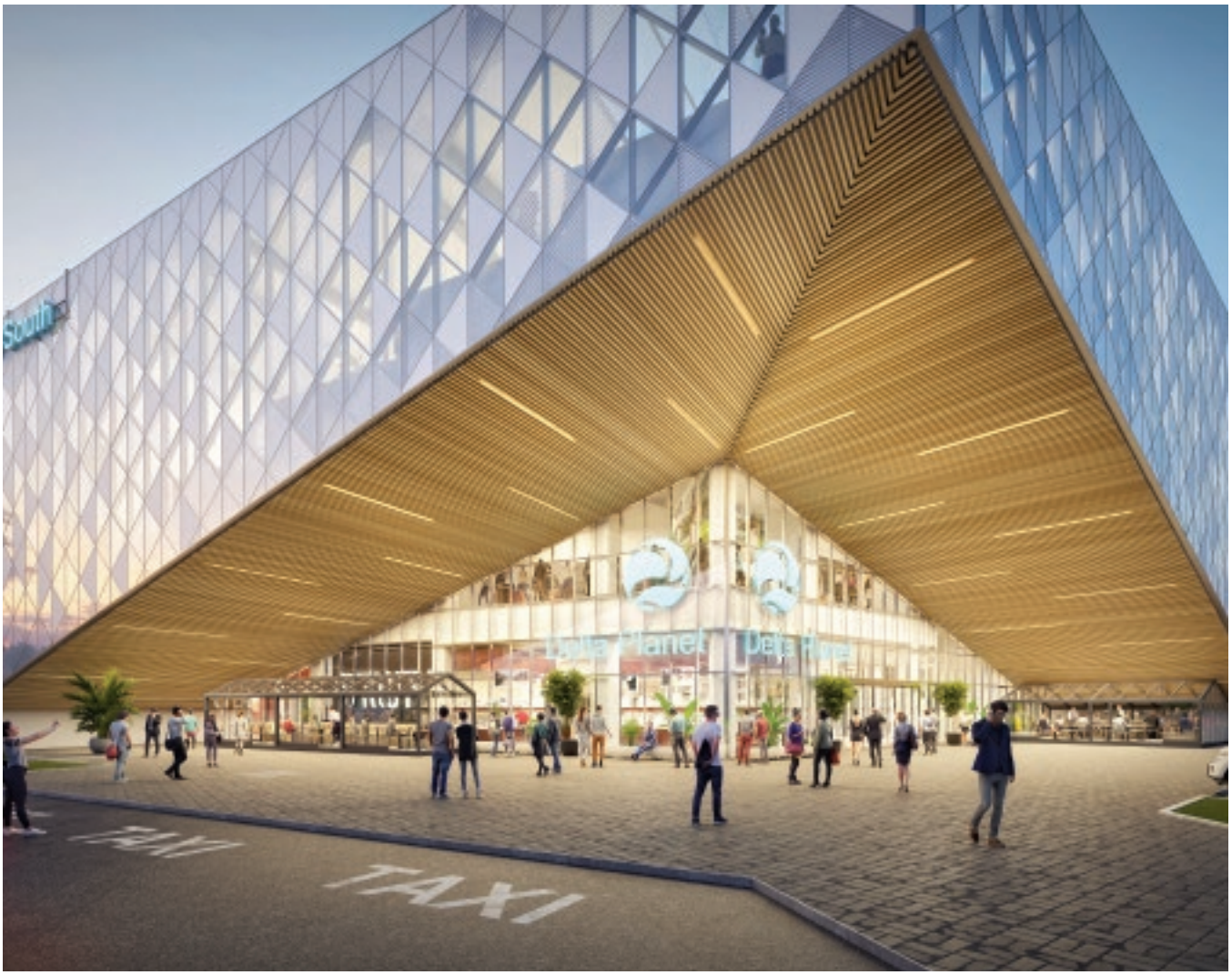
The overall project is valued at €70m and is the largest development to date by Delta Real Estate Group.

Delta Planet Niš will have two floors of retail space for leading international and local brands, as well as restaurants, cafés, playrooms for children and car parking for around 850 vehicles. With its innovative architectural design, the new shopping mall will become a city center landmark and not only draw in visitors, but also create many new jobs. The project contains some 25,000m^2 of post-tensioned slabs which required 120t of steel prestressing strand. In a period of less than five months, BBR Adria had supplied, installed and stressed all of the BBR VT CONA CMM monostrand unbonded post-tensioning tendons.

The biggest challenge for the team was the placement of tendons in the shallow beams which had a curved geometry. To overcome this, the tendons were laid starting with the shortest first. The beams have an open fork armature and due to their great length, five or six team members worked together on the installation.

With all the construction challenges successfully overcome, it is anticipated that this exciting new retail destination will be opened during 2021.

1



2

3

1 Aerial view of construction underway at the Delta Planet shopping mall construction site in Niš, Serbia.
2 Visualization of the main entrance to the Delta Planet retail mall and the winter gardens.
3 Meeting underway between supervisor and technician on site at the Delta Planet shopping mall site where BBR Adria were contracted to provide around 25,000m² of post-tensioned slabs.

TEAM & TECHNOLOGY

Owner/developer – Delta Real Estate
Architect – Ivana Letić
Main contractor – Tehnogradnja d.o.o.
PT design – Centroprojekt d.o.o. & BBR Adria d.o.o.
Technology – BBR VT CONA CMM monostrand
BBR Network Member – BBR Adria d.o.o. (Croatia)

1

Dry goods store, Dunsandel, New Zealand Post-tensioned floor slab

Setting a new post-tensioning record

A 15-year relationship between New Zealand's BBR Contech and Synlait Milk culminated in their biggest-ever project in 2020 – an enormous post-tensioned floor for the dairy-processing giant's brand new Dry Store 4. Having previously installed floors for the customer's Dry Stores 1, 2 and 3 and a coolstore, the team was on familiar ground – but this was a whole new ball game!

The NZ$32 million dry store is located just a few kilometers from the small town of Dunsandel in the South Island's Canterbury region. It's part of a huge complex in which Synlait produces a wide range of dairy products that include infant and adult nutritional formulas, functional food ingredients and specialty products.

Recent history

To deliver these products the company processes more than 700 million liters of milk each year. It's capable of processing 4.2 million liters of raw milk per day, from which up to 440 metric tonnes of milk powder can be produced. Its purpose-built infant formula facility is the largest and most sophisticated in the Southern Hemisphere.

In the past few years Synlait has increased its presence in the market through acquisitions, adding to its product line and strengthening its ability to enter other markets, including China's massive dairy and NZ$25 billion infant food industry.

Reflecting this, the company has recently opened a similar milk powder manufacturing site in the Waikato town of Pōkeno – with 14,516m^2 dry store and Environment Loading Area (ELA) also post-tensioned by BBR Contech – and in 2017 it opened a NZ$55 million blending and canning facility in Māngere, Auckland, a venture that doubled its overall annual packaging capacity to 64,000t.

In a move to boost its growth prospects even further, in 2018 Synlait collaborated with Massey University to open a Research and Development Center at the Palmerston North campus, with a focus on developing innovative dairy liquid products and supporting processes and technology.

DRY STORE 4 IN NUMBERS

25
CONCRETE POURS

359t
STEEL PRESTRESSING STRAND

66,300
LINEAR METERS OF DUCTING

1,732
BBR VT CONA CMF S2 FLAT ANCHORAGES

2

Vast new project

In announcing the Dry Store 4 project, the company said the development would "unlock further supply chain efficiencies and enable greater control of traceability, improving our sustainability footprint, and result in shorter lead times for customers." It would also:

- bring all current South Island offsite warehousing to Dunsandel
- allow temperature-controlled products to be stored at Dunsandel
- reduce the number of inter-warehouse transport movements
- remove double handling and reduce lead-times for its customers
- provide the company with greater control of its inventories, improving customer service, traceability and value-add services
- improve its health and safety practices through new technology and infrastructure improvements.

The current project, awarded to main contractor Calder Stewart, almost doubled the total area of slabs installed in the previous four projects.

Adding up to a vast 45,927m^2, the new project comprised a 29,956m^2, 165mm thick post-tensioned slab on grade as the floor for Dry Store 4, plus twelve 300mm-thick, heavy-duty external pavement slabs, over an area of 15,971m^2 and a total length of 666 linear meters. The external slabs will provide access for the many 40-foot containers being transported by forklifts to a purpose-built rail siding – and ultimately on to Lyttelton Port.

The post-tensioning for the floor in Dry Store 4 consisted of BBR VT CONA CMF S2 flat 406 tendons, while for the external slabs the BBR VT CONA CMF S2 flat 506 system was chosen – 15.2mm steel prestressing strand was used in both cases. Across the whole project, a total of over 66,300 linear meters of two different sizes of ducting was utilized.

As was the case for many BBR Contech projects owing to the Covid-19 outbreak, the project's pace was affected by the New Zealand's Government's decision to close the country's borders and declare various alert levels.

Its announcement of an Alert Level 4 lockdown on 24 March came at a time when one of the pavement slabs had been poured and stressed but was potentially a safety risk until it had been grouted. Fortunately, BBR Contech was given dispensation to send a crew to grout the slab and to complete the same task at three other slab-related projects in the South Island. Of course strict health and safety protocols applied at all times, including requirements to keep contact tracing records and ensure all staff stayed at least a meter apart, took hygiene measures such as hand-washing and surface cleaning, as well as wearing appropriate personal protective equipment.

1 The area of post-tensioned slabs installed for Synlait's new Dry Store 4 project is equal to almost double that of all the slabs installed during the previous four projects.
2 A total of 12 heavy-duty external post-tensioned pavement slabs, each 300mm thick, were installed using BBR VT CONA CMF flat post-tensioning.

TEAM & TECHNOLOGY

Principal – Synlait Milk
Engineer – Babbage Consultants
Main contractor – Calder Stewart Construction
Technology – BBR VT CONA CMF flat
BBR Network Members – BBR Contech (New Zealand)

SPECIAL FEATURE

Stronger, smarter & more durable solutions


EXCAVATIONS


DAMS


SLOPE STABILIZATION


TUNNELLING


WIND TOWERS


BRIDGES

Today, BBR Network Members offer a full range of geotechnical solutions using BBR GT technology. Since BBR's first project back in 1951, the company has continued to develop further technologies and techniques to support the demands of the ground engineering industry for ever stronger, smarter and more durable solutions. To celebrate these seven decades of achievement, we take a look at some of the most interesting projects from the BBR portfolio – from the early days right up to the present – and explore some unique benefits of the latest BBR technology.

Early geotechnical solutions

The story of BBR geotechnical solutions began in southern Switzerland, in the Locarno area on the shores of Lake Maggiore. In the late 1940s, the forces of the Maggia River were being harnessed to produce hydroelectric energy. The first stage of construction involved creating the Sambuco Dam and Reservoir, along with power stations at Peccia, Cavergno and Verbano.

BBR technology was installed in the control centers of all three power stations – starting with the installation of 16 BBRV ground anchors at Verbano in 1951. The underground control centers are founded in rock of varying qualities. The semi-circular caverns are subdivided into a machine room and a valve chamber which needed to withstand the water pressure in the event of a pipe rupture. BBRV anchors were used to stabilize these reinforced concrete constructions and support the overhead crane, as well as the foundations of penstock distributors – the latter also including one at Nendaz served by the Grande Dixence Dam.

SEVEN DECADES – SEVEN THEMES

On the following pages, you will see a small selection from the BBR geotechnical project portfolio – which has greatly expanded over the past 70 years.
The features are grouped in seven main themes.

1

STRUCTURAL STABILITY

Securing existing structures to their landscapes using ground anchoring techniques – such as this project at Wanapum Dam in Washington State, USA – is a major and recurrent feature of the BBR portfolio.

2

WORLD RECORD CAPACITY BBR ANCHORS FOR DAMS

New dam regulations as well as ageing infrastructure prompted the need for ultra-high capacity ground anchors for strengthening dams, such as Wellington Dam in Western Australia.

3

SECURING EXCAVATIONS

BBR geotechnical solutions have been applied to secure the walls of excavations, such as those of the double-track Adler Tunnel on railway lines in Northern Switzerland. Image by Hansruedi Schmutz, CC BY-SA 4.0

Frera Dam, Lombardy, Italy: Consolidation work required 53 BBRV anchors to be installed deeply into the rock on the left side of the dam.

Throughout the 1950s, BBRV anchors were increasingly installed for various purposes within the growing hydroelectric sector. One interesting application was for 65 anchors to counter huge horizontal forces on the cable crane tracks during construction of the Mauvoisin Dam. In a similar fashion, although for somewhat different purposes, BBRV ground anchors were also used for anchoring the téléski terminus of the Eiger Glacier, as well as the upper station of the Attelas cable car at Verbier – and a little later, the San Carlos-Robiei cableway also needed BBRV technology to anchor the pylons to the steep landscape.

In the late 1950s, a project was underway for consolidation of the Frera Dam in Northern Italy. The dam's left shoulder required reinforcement with 53 BBRV anchors secured deeply in the rock. With the benefit of almost seven decades' hindsight, this scheme appears to have been an early signpost to the scale and complexity of future geotechnical projects – some of which are showcased on the following pages.

4

SLOPE STABILIZATION

The securing of rocky overhangs near a railway station on Austria's Arlbergbahn line is one of many projects undertaken using BBR geotechnical technology to prevent landslips. Image by Josef Saurwein, CC BY-SA 2.0, accessed at Wikimedia Commons.

5

HOLD-DOWN SOLUTIONS FOR WIND TOWERS

The installation of BBR geotechnical technology as a hold-down solution for wind towers is a classic application. Shown here is Kjøllefjord Wind Project in Norway.

6

SIX ANCHORING SCHEMES FOR BRIDGES

A brief overview of BBR anchoring solutions which have been installed for a variety of bridges around the globe. Pictured here is Maslenica Bridge, Croatia.

7

UNIQUE & INNOVATIVE GT PROPOSITIONS

Today, BBR geotechnical technologies offer unique innovative features which present great value propositions for all stakeholders.

Structural stability

At the start of the 1960s, major projects to enhance the stability of two new dams in Switzerland and the USA – plus a huge game-changing project in Australia – saw not only the installation of BBRV anchors, but also the expansion of the BBR business right around the globe.

1 SOLVING FOUNDATION PROBLEMS

The installation of 166 BBRV anchors, vertical and inclined, solved many foundation problems for both temporary and final works of the new barrage at Schaffhausen on the River Rhine. Between 1959 and 1963, a temporary dam, various cofferdams, then the piers and the raft of the gate dam were anchored in the limestone banks forming the bed of the river.

2 WORLD'S LARGEST DAM REHAB WITH PT ANCHORS

In Maryland, USA, there were concerns about the Conowingo Dam after the heavy rains, brought in 1972 by Hurricane Agnes, had raised the water in the reservoir to 0.8m above its normal level. The decision was taken to upgrade the then 50-year old dam, initiating what was thought to be the biggest dam rehabilitation project using post-tensioned anchorages in the world. The project involved drilling through some 60m of concrete and bedrock to install 1,100t of prestressing steel in the form of 537 BBRV rock anchors. Today, the dam provides feedwater for hydroelectric power generation, cooling water for a nuclear power station and water for public supply.

3 STABILIZING INTAKE SECTIONS

In the early 1960s, BBRV rock anchors were being used to stabilize intake sections of the Wanapum Dam in Washington State, USA, allowing for later construction of the power house substructure. Thirteen anchors were placed in each intake and holes were drilled to a depth of 24m into the rock foundation. After structural concrete had been placed and attained the required strength, the anchor assemblies were lowered into the drilled holes and the bottom nine meter length was grouted.

4 INCREASING DAM CAPACITY

In 1965, two dams on the Spullersee lake in Austria needed strengthening before they were raised to increase capacity. This double dam project required the installation of 118 BBRV ground anchors and, because of the unique nature of the challenge, created much interest among the engineering community.

5 NEW ERA DAM STRENGTHENING

By the 1990s, around the world there were many dams – originally built decades earlier with old technology and often structurally altered in the years which followed – which were then showing signs of ageing and did not meet modern safety standards. One such project was Waitakere Dam, near the city of Auckland in New Zealand where BBR technology and experience was brought to the complex structural upgrading project required for conformance with modern earthquake practice. This curved concrete gravity dam was built in 1910 had been raised in 1928 from a height of 18m to 23m.
The main feature of the upgrading work consisted of the installation of 55 vertical BBR CONA rock anchors with maximum lengths of 60m. The anchors have the facility for continuous load monitoring and re-stressing during the entire life-span of the structure. In addition, 260 BBRV post-tensioning tendons were installed in the dam to stress together the sections of the original dam and the dam built in 1928. Two BBRV tendons were provided for each vertical rock anchor to resist bursting stresses.

6 SNOWY HYDRO SCHEME, AUSTRALIA

This massive construction program was to occupy over 100,000 workers during a 25-year period for the creation of nine power stations – two of which are underground – and 16 major dams, plus 80km of aqueducts and 145km of interconnected tunnels. Rock anchoring work was undertaken on a huge scale to prevent large tunnels and caverns from collapse. It was as a result of this project that, in 1961, Australian BBR Network Member BBR Australia Pty (later Structural Systems and now SRG Global) was founded.

1 Schaffhausen Dam, Switzerland: This recent photograph shows Schaffhausen Dam in the background, behind another later BBR project – the cable-stayed N4 Rhine Bridge. Image courtesy of Wandervogel, licensed under CC BY-SA 3.0, accessed at Wikimedia Commons.
2 Conowingo Dam, Maryland, USA: Considered at the time to be the world's largest dam rehabilitation project using post-tensioned anchorages, 537 BBRV rock anchors were installed. Image by NortyNort, licensed under CC B SA 4.0, accessed at Wikimedia Commons.
3 Wanapum Dam, Washington State, USA: BBRV rock anchors were used to stabilize intake sections, allowing for the later construction of the power house substructure.
4 Spullersee Dams, Austria: Two dams on the Spullersee lake in Austria were strengthened using a total of 118 BBR rock anchors before they were raised to increase capacity.
5 Waitakere Dam, Auckland, New Zealand: BBR CONA rock anchors and BBRV post-tensioning tendons were installed for the structural upgrading work on this ageing dam.
6 Snowy Mountains Hydroelectric Scheme, Australia: TOP: Turbine Hall of Murray 1 Hydroelectric Power Station, New South Wales, Australia. Image by Martin Kraft, licensed under CC BY-SA 3.0 DE, accessed at Wikimedia Commons. BOTTOM: The Tumut 3 Power Station. Image by Thennicke, licensed under CC B SA 4.0, accessed at Wikimedia Commons.

Quartet of versatile solutions

SOLUTION 1

World record capacity anchors for dams

Just over 20 years ago the pressure on dam owners brought about by new dam safety guidelines and ageing dam infrastructure, as mentioned earlier, plus the requirement to increase energy production, led to the need for major specialist construction engineering support. The combination of BBR technology and great innovation by the BBR Network – most notably by SRG Global, the BBR Network Member for Australia – has delivered a succession of projects using world record capacity BBR anchors for dam strengthening schemes. Pictured here are Canning Dam (left) which was the first project where massive BBR anchors were used and (right) tendon stressing work underway at Catagunya Dam in Tasmania, the second dam to be strengthened with world record capacity 91-strand BBR ground anchors.

SOLUTION 2

Securing excavations

BBR geotechnical technology has, over the years, been used to secure the walls of many underground structures. Here, we take a look at two similar applications – on opposite sides of the globe. The image on the left shows the excavation for the University of Hong Kong which was secured with permanent BBR CONA ground anchors. Meanwhile, on the right is the construction site for the 5.3km long double track Adler Tunnel on the railway line between Muttenz and Liestal in northern Switzerland. The excavation for the tunnel was secured with temporary BBR CONA ground anchors of up to 40m long.

SOLUTION 3

Slope stabilization

As early as the 1960s, BBR ground anchors were used to stabilize slopes and prevent landslips. Pictured left, is the Swiss A2 motorway close to the shores of Lake Lugano. The slope on which two new tunnels were being constructed – just above an existing railway line – began to move. The most economical solution was to install 32 prestressed BBRV ground anchors. The image on the right shows part of the discontinuous wall system adopted to stabilize the slope above the Bachmattli section of the new RN8 national highway. Here, a total of 289 BBRV 1,400kN ground anchors were installed.

SOLUTION 4

Hold-down solutions for wind towers

Humans have been harnessing energy from the wind almost since time began. However, the modern age of wind power is considered to have begun in the 1970s since when there has been a quest for ever taller towers and more powerful turbines – demanding the strongest technology for their construction, operation and longevity. On many occasions across many projects, BBR technology has been applied to the towers themselves and also as hold-down solutions for the massive foundations. Pictured on the left is Kjøllefjord Wind Project, Norway; on the right are Åmot-Lingbo Wind Farm (upper image) and Årjäng Wind Farm, both in Sweden.

Six anchoring schemes for bridges

From the BBR global portfolio, we have chosen six bridges – all with different anchoring requirements – to demonstrate the wide range of applications for BBR ground anchors in bridge construction.

1 Creating new records

The first major project of this type to feature BBR rock anchors is believed to have been Tancarville Bridge over the lower Seine in France. Work on the bridge began in 1955 to the design of celebrated structural engineer Nicolas Esquillan of Boussiron. As well as the creation of the then tallest suspension bridge pylons in the world, his vision also called for the construction of a massive concrete block on the right bank of the river in which the enormous suspension cables would be anchored, thus transferring loads from the bridge to the ground. To secure the concrete block, 120 BBRV ground anchors were installed and, with a length of around 75m, these were thought to be the largest rock anchors yet executed. Coincidentally, among the many contractors tasked with delivering the project was Fougerolle, now part of the Eiffage Group, the parent company of French BBR Network Member ÆVIA.

2 Securing bridge beam

Another early major project was on the Axenstrasse near Brunnen where the A4 motorway emerges from the Mositunnel. In the mid-1960s, a new highway viaduct was under construction with work being carried out in dramatic and crowded terrain. The site was on the steep slopes sweeping down to the Vierwaldstätter Lake and above a railway line and old tunnel. The new viaduct deck rests partly on a corbelled structure and partly on slender pillars. Seven BBRV ground anchors were used to secure the beam supporting the new roadway to the limestone geology.

3 Anchoring to bedrock

In the 1980s, the dramatic San Roque González de Santa Cruz Bridge was under construction across South America's Parana River between Argentina and Paraguay. The end piers of this cable-stayed bridge were designed to withstand ship collision. Therefore they are anchored to the bedrock by means of eight BBRV ground anchors, each with 270 x 7mm diameter wires and stressed to 11,250kN. Available jack capacities meant that the ground anchors needed to be divided into three bundles of 90 wires each, which fitted into a 300mm diameter borehole.

4 Anchoring for temporary stays

During the mid-1990s, construction of the Maslenica Bridge in Croatia – by the suspended cantilevering method – offered a further opportunity to demonstrate the strength and versatility of BBR geotechnical technology. This 200m long open spandrel arch bridge was constructed from both river banks simultaneously in stages of 5.25m with the help of temporary stay cables which were firmly secured to the rock face using BBRV ground anchors.

5 Back span anchoring

In 2003, construction of the Krishnarajapuram Bridge in Bangalore, India – known by many as 'the hanging bridge of Bengaluru' – was underway. Featuring BBRV post-tensioning for the deck and BBR DINA wire stay cables, the bridge also required BBRV ground anchors to secure the short back span bridge abutment to the ground.

6 Anchors for added strength

The final insight in this section takes us to the famous Hardangerfjord – the world's third longest fjord and second longest in Norway. Here, in 2010, BBR Network Member for Norway KB Spennteknikk AS was installing rock anchors.

As the tower foundation area is very steep, the main contractor wanted to reduce the size of the foundations – consequently, the quantity of rock anchors increased. From an original requirement for 32 BBR CONA 1206 rock anchors, with the new foundations the number then increased to 52 – all of which were installed in October 2010.

Meanwhile, the suspension cables are anchored by 76 BBR VT CONA CMI 2506 tendons installed on each side of the fjord. The cables were placed in individually drilled holes from the upper anchorage zone down to a tunnel where they were anchored. To complete the picture, we should also mention that 78 BBR VT CONA CMI 1506 tendons were used for the three prestressed box girders, while the CONA CMI 1906 system was used to post-tension the access viaduct. This magnificent bridge opened in 2013, shortening journey times for all.

1

1955 – Tancarville Bridge, Seine-Maritime, France: Constructed in the late 1950s, this landmark project featured 120 BBRV rock anchors which were installed to secure the huge concrete block where the bridge's suspension cables are also anchored.

2

1960s – Axenstrasse near Brunnen/Mositunnel, Switzerland: Seven BBRV ground anchors were used to support the new viaduct where the Axenstrasse joins the A4 motorway after it emerges from the Mositunnel. Image courtesy of ETH-Bibliothek Zürich, Bildarchiv, Photographer: Comet Photo AG (Zürich), Reference: Com_F65-05257, licensed under CC BY-SA 4.0.

3

1980s – San Roque González de Santa Cruz Bridge, Argentina/Paraguay: BBRV ground anchors were installed in the end piers of the bridge for strengthening in case of ship collision. Image by Maurice Chédel, licensed under CC BY-SA 3.0, accessed at Wikimedia Commons.

4

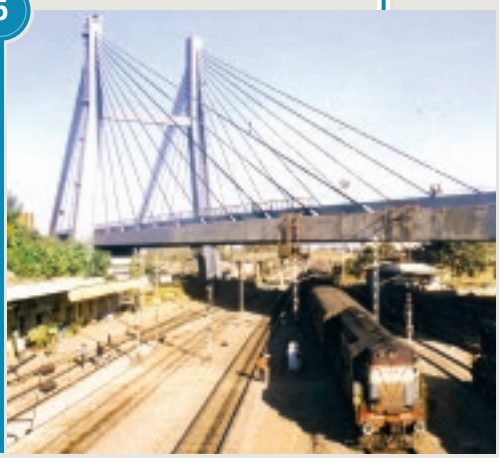
1990s – Maslenica Bridge, Croatia: BBRV ground anchors were used to secure the temporary stay cables to the rock face during construction of this arch bridge.

6

2010 – Hardanger Bridge, Norway:
TOP: The suspension cables for the bridge are anchored in a tunnel by CONA CMI tendons. Image courtesy of Per Frode Bu, www.bugard.no, perbu@eidford.net.
BOTTOM: View of the completed bridge which not only features BBR CONA rock anchors, but also CONA CMI tendons for anchoring the suspension cables and for the deck post-tensioning.

5

2003 – Krishnarajapuram Bridge, Bangalore, India: As well as a BBRV post-tensioned deck and BBR DINA stay cables, the bridge also has a back span secured with BBRV ground anchors.



Advantages of BBR geotechnical solutions

Designed to suit many applications and satisfy most customer demands, BBR geotechnical solutions are typically applied in civil and ground engineering works, as well as for maritime or tunneling applications and in the energy sector. Broadly, the new BBR geotechnical business line offers:

- Widest size range of strand anchors in the marketplace.
- Alternative and complementary bar solutions (BBR H & C Bar).
- Various corrosion protection levels.
- Digital & paperless purchase order processing.
- European Factory Production Control & Quality Assurance.
- Stock-keeping and warehouse management.

Unique & innovative GT propositions

As with all BBR technologies, the geotechnical product range has been refined and expanded over the years. Today, as well as reliability and versatility, BBR geotechnical technologies offer innovative features which are unique in the global market place and present great value propositions for all stakeholders. BBR VT International's Deputy CEO Cezary Sternicki offers a brief insight into the range and highlights some of the advantages.

Deep understanding

BBR has 70 years of experience in ground anchoring, which encompasses not only detailed knowledge of load transfer and long-term behavior of ground and rock anchors, but also of installation procedures and works execution.

The BBR Network's knowledge and experience, along with the most recent findings on corrosion protection and durability, have been applied to develop and introduce the BBR VT CONA CMG strand ground anchor and to extend BBR geotechnical solutions with the BBR Bar range.

Deep understanding of the challenges associated with specific applications is crucial when developing geotechnical technologies. These applications might include providing stability for retaining structures with tie-back anchors, securing foundations against uplift with pre-tensioned micropiles, securing endangered rock fall areas with rock and soil nails or pinning down the vertical structures with hold-down bolts – to cite just a few examples.

The design and subsequent production of such technologies must be undertaken with the ultimate application type in mind, and thus the behavior of specific technology and its durability will heavily depend on whether the system is, for example, pre-activated by post-tensioning – like strand

1 BBR has 70 years of experience in ground anchoring, encompassing not only detailed knowledge of load transfer and long-term behavior of ground and rock anchors, but also of installation procedures and works execution.
2 BBR geotechnical solutions are typically applied in civil and ground engineering works, as well as for maritime or tunneling applications and in the energy sector.

BBR GEOTECHNICAL & BAR TECHNOLOGIES

BBR VT CONA CMG STRAND GROUND ANCHOR

Designed for geotechnical applications, as a soil or rock anchor offering state-of-the art performance, across three corrosion protection levels, plus widest size & strength ranges.

BBR SDX BAR SYSTEM

Fully threaded hollow bar system offered in three corrosion protection levels, complete with a selection of accessories, designed to suit the widest variety of ground conditions & working environments.

1

2

ground anchors – or whether it is a passive application where activation is initiated only by the movement of the anchored structures. Ensuring performance and durability also requires experience. By applying our decades of knowledge gained in the practical on-site application of geotechnical anchoring solutions, combined with the latest materials technology, our R&D team has developed systems which offer unrivaled robustness, strength and flexibility.

Latest strand ground anchors

The BBR VT CONA CMG strand ground anchor is state-of-the-art with its unique sealing system which ensures a fully encapsulated truly double layer of protection in the anchorage and transition zone.

There is also advanced leak-tightness and sealed GT monostrand which resists up to 3.5 bars of water pressure. It is also the only proven double corrosion protected system on the market – because testing has shown that grout crack widths are limited to 0.1mm. Great performance – and only requiring one layer of corrugated plastic duct. When you then add the fact that the system offers the widest range of strand ground anchors anywhere on the international market, the proposition becomes especially compelling.

Geotechnical bar solutions

The BBR SDX Bar System was designed with both performance and maximum on-site productivity in mind. As well as ensuring excellent grout bonding, the continuous R- or T- thread of the SDX bars is also compatible with easily available drilling machines and allows bars to be cut and coupled at any point. The latter is particularly useful when bars are to be installed in locations where access is restricted or clearance is limited.

With a comprehensive range of drilling bits, installation could not be easier. In one operation, the SDX Bar system offers the option of simultaneously drilling, flushing the borehole (with water or air) and grouting – ensuring proper grout distribution along the whole tendon length.

The BBR Bar family of threaded bars also features the BBR C Bar which has superior fatigue performance and has been tested to 10 million load cycles. This is a key component of the BBR WT Bar system which is designed for hold-down applications such as in the wind tower market and has increased corrosion resistance thanks to its double layer protection.

Unique quality solutions

As well as other widely publicized unique selling points, BBR is offering highly customized technical solutions in a 'commoditized' manner. Our online trading platform – BBR E-Trace – not only provides a contact- and paper-free ordering method, but also complete Quality and Factory Production Control with full traceability of products from the raw material state right up to installation on site. As well as being an innovation in the very traditional geotechnical market, this has also proved to be the right solution in this currently challenging time.

BBR WT BAR SYSTEM

Multi-layer corrosion protected hold-down bolt for wind tower foundations and also for any hold down applications where high fatigue performance and permanent multi-layer corrosion protection is required.

BBR C BAR SYSTEM

High fatigue performance and corrosion resistant fully-threaded cold rolled alloy steel bar system, suitable for use as a post-tensioning bar, hold down bolt or tie bar in bridges, buildings and both retrofitting and new build applications.

BBR H500/670/930 BAR SYSTEM

Hot rolled and coarse-threaded bar system for temporary and permanent applications, featuring the widest range of bar diameters in the international market place and ideal for the most complex and technically challenging construction and underground applications.

Residential & commercial complex, Zagreb, Croatia Ground anchors for basements

City center development

In the heart of the Croatian capital city of Zagreb, a prime development site has burst into life again after being silent since the early 2000s. Local BBR Network Member BBR Adria is literally at the very foundations of the project. Enis Dauti, Engineering Technologist, offers a brief insight into his company's work for the exciting new commercial and residential scheme which is currently under construction.

1

2

We were contracted to provide ground anchoring services to the Kneza Borne – Kneza Branimira residential and commercial complex in central Zagreb. Temporary anchors were needed to anchor vertical walls during excavation for the subsurface levels of the new structure. Mostly, the anchors were installed in gravel and, where neighboring buildings were close, the anchors were post-grouted. As part of the excavation had already been completed – including installation and stressing of geotechnical anchors – before work was halted on the site in the early 2000s, in some cases we installed new anchors alongside the old ones. We used temporary BBR CONA SOL+ strand anchors with four strands each. In the first row, the tendons were 18m long and they were 16m in the second.

In many ways, this was a model project – installation work went according to plan and lasted from January to September 2020. We now look forward to seeing a completed building on this long-deserted prime piece of city center real estate.

1 Where there were neighboring properties close-by, the BBR CONA SOL+ ground anchors were post-grouted as well.
2 BBR Adria Engineering Technologist Enis Dauti is pictured here beginning the stressing process for one of 292 BBR CONA SOL+ temporary ground anchors installed for a major city center residential and commercial development in Zagreb, Croatia.

TEAM & TECHNOLOGY

Owner – VMD Model d.o.o.
Main contractor – Grasa d.o.o.
Technology – BBR CONA SOL+ ground anchor
BBR Network Member – BBR Adria d.o.o. (Croatia)

Sluiceway Bridge, Yusufeli Dam, Turkey BBR H500 Bar for load transfer

Transferring load with BBR H Bars

As CONNÆCT 2021 goes to print, the project to install a steel sluiceway bridge, using BBR H500 Bars, at the massive Yusufeli Dam is nearing completion. Civil Engineer Ferit Kutay of BBR Network Member Kappa presents an insight into the team's approach to this challenging task.

TEAM & TECHNOLOGY

Client – DSi (Devlet Suileri) – General Directorate of State Hydraulic Works
Main contractor – Limak Construction A.S.
Climbing formwork specialist – ÇEKA Beton Kalibi Ltd. Sti.
Technology – BBR H Bar
BBR Network Member – Kappa AS (Turkey)

The 275m high double curvature Yusufeli Dam will be the highest arch dam in Turkey and is part of a major hydroelectric scheme on the Çoruh River. The new dam has been built using climbing formwork that was specially designed and manufactured. For ease of installation and maintenance, a steel bridge design was chosen for the sluiceway access road.

The design of the steel sluiceway bridge, which is being installed using BBR H500 Bars, for the Yusufeli Dam in Turkey allowed the contractor to fabricate the access road without interrupting the construction of the main dam wall.

Step-by-Step Guide

1

The 110m long steel sluiceway bridge comprises 14 individual modules. The 6.5m width of the bridge allows the passage of two H30-S24 trucks. Pictured here, a section of completed steel bridge can be seen on the right and the series of cut-outs for securing the bridge trusses leading to the sluiceway on the left.

2

Each bridge module rests on the body of the dam through a steel truss system which also features permanent platforms, beneath the roadway, to permit bridge maintenance.

3

The tensile load of the truss system is transferred to the dam body using 40mm diameter BBR H500 Bars. The project will require a total of 112 BBR H500 Bars.

4

Four BBR H500 Bars are being installed for each of the 28 truss beams. After completing the assembly, the BBR H500 bars will be covered by concrete capping and a composite steel and concrete deck slab will be constructed to complete the sluiceway bridge deck.

Wharf repairs, North Island, New Zealand MRR techniques in maritime settings

Future-proofing by the sea

Given that New Zealand is surrounded by water, it's no surprise that BBR Contech is often asked to undertake wharf repairs. The quality of its work and the strength of its client relationships are evident in the amount of repeat business that comes its way and its recognition as a market leader in the field. BBR Contech's wharf projects feature regularly in CONNÆCT, providing timely reminders of the destructive forces of the sea and the value of vigilance in keeping wharves in great shape. In this issue, we look at three recent wharf repair projects in the North Island.

1

2

1 Napier, Hawke's Bay

Napier Port's 50-year-old, 300m-long wharf is used by cruise ships and for loading and unloading cargo and fuel. It's an important feature of the port's operations, which include exporting apples, pears, stone-fruit and grapes, as well as large amounts of sheep's wool, frozen meat, wood pulp and timber.

In August 2019, BBR Contech undertook a project to remedy a gradual deterioration in the wharf's beams and piles. The team's role was to remove the defective concrete using hydro-demolition then dry-spray gunite onto the exposed surfaces. The challenge, as always with this kind of work, was to gain access to the affected areas – which meant keeping a careful watch on the tides and the shipping activity around the port. ›

3

4

2 Whakatāne & Ōhope, Bay of Plenty

In mid-July 2020, BBR Contech won a contract to undertake repairs at the 100-year-old Whakatāne Town Wharf and Ōhope Wharf – two wharves in eastern Bay of Plenty located just a few minutes' drive from each other. Similarly to the Napier project, the work involved removing defective concrete using hydro-demolition, replacing corroded reinforcement and reinstating a total of around 90m^3 of defective concrete and corroded reinforcing, by spraying or recasting.

BBR Contech's submission had a strong focus on supporting the Whakatāne community through what had been a difficult time. It included a commitment to engaging local contractors and suppliers as much as possible and employing local people who had lost their jobs owing to the Covid-19 crisis downturn.

The work was enabled through the New Zealand Government's Provincial Growth Fund, which was established in 2018 to enhance economic development opportunities beyond New Zealand's main business centers. As well as funding the wharf repairs, the fund will support the development of a new boat harbor and a revitalization program for the Whakatāne riverfront area which is designed to create a 'dynamic heart' for residents.

5

...the work involved removing defective concrete using hydro-demolition, replacing corroded reinforcement and reinstating a total of around 90m^3 of defective concrete and corroded reinforcing, by spraying or recasting.

6

7

1 Napier Port: The 50-year old wharf needed a 'makeover' – removal of defective concrete, replacement of corroded reinforcement and a new coating of concrete – to ensure its continued service life.
2 Napier Port: The challenge was to gain access to the affected areas – the team used the 'Contech 2' mini-barge and, to alert wharf-users above, installed an orange warning cone on the deck.
3 Napier Port: The team worked on platforms suspended beneath the wharf to remove defective concrete by hydro-demolition and apply dry spray gunite to the exposed surfaces.
4 Ōhope Wharf: Hydro-demolition was undertaken to remove defective concrete beneath the wharf.
5-7 Whakatāne Town Wharf: Damaged concrete was removed from the underside of the wharf and corroded reinforcement was replaced before reinstating concrete using spraying or recasting techniques.

TEAM & TECHNOLOGY

1 NAPIER

Client – Napier Port
Main contractor – BBR Contech
Hydro-demolition subcontractor – Intergroup
Technology – MRR range
BBR Network Member – BBR Contech (New Zealand)

2 WHAKATĀNE & ŌHOPE, BAY OF PLENTY

Client – Whakatāne District Council
Main contractor – BBR Contech
Technology – MRR range
Hydro-demolition subcontractor – Intergroup
BBR Network Member – BBR Contech (New Zealand)

Seatoun Tunnel, Wellington, New Zealand Strengthening & refurbishment

Connecting communities

A recent project undertaken by New Zealand's BBR Contech has provided a small seaside community with an assurance of safety in the event of an earthquake.

First settled by Europeans in the late 1800s, Seatoun is now one of the most prestigious suburbs in Wellington, New Zealand's capital city. Its numerous beaches and lengthy coastline make it a popular visitor destination, while its closeness to the central business district enables easy commuter access. House prices are inevitably high – in 2019, Seatoun was ranked the second-most expensive suburb in Wellington.

Main access route

One of the keys to Seatoun's popularity is the Seatoun Tunnel – a 144m long structure that, when built in 1907 at a cost of £23,000, provided a tram connection between Seatoun and the then young city of Wellington. No longer was it necessary to take a long ferry trip or make an arduous journey in dense bush over Seatoun Hill. The previously isolated community began to thrive and today, the tunnel is still the main access route for private and public transport between city and sea, as well as for walkers and cyclists.

Seismic strengthening & upgrade

In 2011 the tunnel structure was assessed as part of a Wellington City Council program to ensure the resilience of its key transport routes and, while not considering the tunnel to be at high risk of damage or collapse, the engineers concluded that its portals required strengthening. The NZ$1.8 million project began in August 2019, with the council taking the opportunity to extend existing steel handrails along the tunnel's internal footpath and replace the sodium lights with new, more efficient LED fixtures.

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The project was another opportunity for BBR Contech, as head contractor, to apply its expertise as a specialist in tunnel-portal strengthening. In previous years, the company has also strengthened the nearby Mt Victoria and Hātaitai Bus Tunnels. The Seatoun requirements were similar and included:

- building new buttress overlay beams in front of the existing ones on both sides of the tunnel
- constructing ground beams behind the parapets of both portal walls
- installing 20 rock anchors – 10 on each side of the tunnel
- repairing defective areas and painting both walls
- constructing a new ground beam in front of the retaining wall, to be held in place with four rock anchors.

Early completion despite challenges

While this may sound straightforward, the project had its challenges, including a requirement to maintain safe traffic passage at all times and, given the tunnel's residential neighbors, to minimize noise as much as possible – especially when working at night. It also had its rewards, with completion ahead of schedule in May 2020, despite the inconvenience of a four-week pause in proceedings owing to Wellington's 'Alert Level 4' status necessitated by the Covid-19 coronavirus outbreak. The result is a structure built to the highest standards of safety and earthquake resilience – and a community infrastructure asset that will enable residents to come-and-go for many years to come.

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1 With the strengthening and improvements to Seatoun Tunnel completed, representatives from the client Wellington City Council, engineer WSP and main contractor BBR Contech lined up for a commemorative photograph.
2 A new beam was constructed in front of the retaining wall and held in place with four rock anchors.
3 The team is working to install 20 rock anchors, 10 on each side of the tunnel.

TEAM & TECHNOLOGY

Client – Wellington City Council
Consulting engineer – WSP
Main contractor – BBR Contech
Technology – PT bar ground anchor
BBR Network Member – BBR Contech (New Zealand)

MUK Prievoz, Bratislava, Slovakia Application of external post-tensioning

Return to Bratislava

Having completed the post-tensioning of five bridges last year, the BBR Polska team was called to Slovakia once again to supply further specialist construction engineering expertise for the MUK Prievoz part of the massive Bratislava Bypass project. This time, they are installing external post-tensioning for eight existing highway viaducts. Project Manager Tomasz Borsz and Project Engineer Aleksandra Basta outline the project and scope of work.

The MUK Prievoz interchange was originally built in the 1980s and features eight separate viaducts on the D1 motorway. Strengthening work is necessary to bring the highway into line with current standards and ready for its role as part of the new R7 Expressway route.

Strengthening overview

BBR Polska was appointed to strengthen the viaducts with exchangeable external post-tensioning tendons. Prior to installation of the BBR VT CONA CME external post-tensioning, we are installing and stressing PT bars to secure new structural elements, such as anchorages and deviators.

The photographs here show the 120m long three span Bridge Number 212 which was built in 1988. For this bridge, we installed two 16-strand CONA CME tendons in the longitudinal direction, inside the concrete box cross-section. The strands were inserted into the ducts and the tendons were then stressed and, finally, grouted to provide corrosion protection.

Post-tensioning scope

Work on the underside of the bridge was carried out using a telescopic hydraulic access platform which allowed the team to install the passive anchorages for the PT bar system.

The PT bars were stressed from the inside of the bridge beam. In total, 1,380 PT bars ranging in diameter from 32mm to 47mm will be installed, stressed and cement grouted. The excess length of the PT bars was cut after stressing, protection caps were installed and then grouting was carried out.

Across the project as a whole, we will be installing, stressing and cement grouting a total of 94 BBR VT CONA CME external post-tensioning tendons ranging from 15 strands to 22 strands. The new PT tendons pass through the cast in situ anchor blocks and holes drilled in the bridge's crossbeams, and are finally secured at their anchorages.

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Exchangeable tendons

For some years now, the BBR VT CONA CME external post-tensioning has been supplied as an exchangeable system and this is what we are using to meet the requirements of this project. This solution has grown in popularity because it allows the replacement of the entire CONA CME tendon, should it ever become necessary.

Overcoming challenges

Working to a completion deadline of mid-2021, this project delivered many challenges for the BBR Polska team. First, there was the need for an adaptation of PT bar and PT systems to meet the client's specific requirements. Then there are the organizational issues involved in working abroad and in an international environment – the site is in Slovakia and our client is an Austrian-Spanish joint venture between PORR and FERROVIAL. On the site itself, there are traffic management considerations as this is a live junction where traffic flows cannot be interrupted. In addition, there have been changes in site organization, variations in technical design with changes in the scope of works and we have needed to adapt our systems to suit the existing structure. Lastly and not least in this project which for us began in 2020, there has been the Covid-19 coronavirus situation – bringing with it travel restrictions, health measures, quarantine and lockdown.

Despite all these challenges, the project is progressing very well, thanks to a unique combination of people and technologies. We have supplied world-class PT and bar technologies, installed by an experienced and well-motivated BBR Polska site team. We have enjoyed great professional support from BBR Polska's head office personnel and they, together with our site team, have exhibited much organizational agility in terms of adapting to project and environmental changes. The highly productive collaboration with our customer and, of course, the excellent and timely technical support from BBR HQ in Switzerland have been particular highlights of this project.

1 Work on the underside of the bridge was carried out using a telescopic hydraulic access platform which allowed the team to install the passive anchorages for the PT bar system.
2 Stressing of the PT bars is underway – they were installed to secure new structural elements such as deviators and anchorages for the CONA CME external PT system.
3 Working inside the bridge beam, excess length of the PT bars was cut.

TEAM & TECHNOLOGY

Client – Zero Bypass Ltd (Concessionaire) Ministry of Transport, Construction and Regional Development of the Slovak Republic (Public Authority)
Consulting engineer – DOPRAVOPROJEKT a. s.
Main contractor – D4R7 Construction s.r.o.
Technology – PT bar, BBR VT CONA CME external
BBR Network Member – BBR Polska z.o.o (Poland)

Reassuring resilience

Two office buildings in New Zealand are now in much better seismic shape thanks to strengthening projects undertaken by BBR Contech.

Investing in New Plymouth

The global Covid-19 coronavirus outbreak spooked a lot of New Zealand businesses into postponing their plans for new investments. However, OMV New Zealand did quite the reverse.

OMV is one of New Zealand's largest liquid hydrocarbon producers and its largest gas producer. It's also a major explorer in a number of offshore basins around New Zealand, particularly the Taranaki Basin. Its head office is in Wellington and its operations base is in the Taranaki city of New Plymouth.

In June 2020, the company announced its intention to move to a new location in New Plymouth – a six-storey 1970s building on which it would spend NZ$15m for refurbishment work. The move represented a significant cash injection at a crucial time for the economy and underscored OMV's long-term commitment to the wider Taranaki region. What's more, up to 90% of the budget would be spent locally in New Plymouth and with New Zealand suppliers.

Extensive upgrade program

The upgrade program was far-reaching. The building would get a new roof, the extensive leaks would be repaired, double glazing would be installed and seismic strengthening would be undertaken to ensure the building complied with New Zealand's Building Code.

BBR Contech was appointed as a specialist contractor to the seismic strengthening project, and worked with Tse Taranaki & Associates to design the approach. This proved to be a productive relationship, with the building's final seismic design enabling the structure to meet 100% of New Building Standard (NBS) – the standard to which a new building must be constructed in New Zealand.

"We were delighted with this solution," said Kai Kibble of OMV. "It provides huge reassurance of the building's resilience in an earthquake and of course the safety of the OMV team and other occupants. It also illustrates the value of BBR Contech's experience and expertise, it was great to have them on board."

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Specialist design & construction

BBR Contech's specialist design and construction delivery involved strengthening the building's floor diaphragms over six levels.

CFRP (carbon fiber reinforced polymer) installation involved bonding 4,000m² of CFRP fabric to the top of each floor slab, then applying 3,000 linear meters of CFRP anchorage to all termination points. A cementitious floor leveling compound was then applied to the entire floor, both to protect the CFRP and level the slab's surface in preparation for carpet and vinyl floor laying. Covering a total 4,124m² of floor plate, the work was completed in 12 weeks at a cost of NZ$1.4m.

'Essential' project

Given all the events happening in the wider world, the project wasn't without complications, as New Zealand's nationwide lockdown in response to Covid-19 started three weeks into the design and build program. Fortunately work was able to start five weeks later, as the project was considered an 'essential' part of the economic recovery – but while those five weeks had enabled the design team to make good progress, the pressure was then on those working on the implementation side and, of course, there were strict hygiene, health and safety protocols to follow too.

The building provides a workplace for 300 OMV staff and contractors, as well as housing the 24/7 control room for the Pohokura gas field, which lies 4km offshore. The field has been in production since 2006 and currently meets about 40% of New Zealand's gas demand. Now, with work completed, OMV's staff can rest assured in the knowledge that their new offices reflect the latest national standards in seismic design. ›

BBR Contech's specialist design and construction delivery involved strengthening the building's floor diaphragms over six levels.

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Repeat business in Auckland

This three-storey office building, Opus House, is located in the heart of Manukau – the largest and most established of Auckland's suburbs outside the city center. Located about 20km from the CBD – and, since 2012, connected directly to the Auckland rail network – the area provides civic, retail, education and cultural facilities for the wider population of south Auckland.

The building was constructed in the 1990s and required seismic strengthening to comply with New Zealand's Building Code. BBR Contech was awarded the 12-week, NZ$400,000 contract on the back of a number of previous projects undertaken alongside Compusoft Engineering. BBR Contech was also appointed head contractor which meant sourcing all materials, overseeing the entire project, participating in the steelwork installation, completing the seismic strengthening work, as well as commissioning and managing subcontractors.

Working constraints

The team's ability to complete the project was complicated by the fact that the building remained 50% occupied throughout. This meant all the occupants had to have all-day access to the building during the week and, of course, minimal disruptions during their working day. This meant a lot of evening work for the crew.

Technical details

The project saw the BBR Contech team attaching 10mm thick, angled steel plates to the walls to prevent hollow-core flooring units dislodging and 'pancaking' in the event of an earthquake. They also embedded steel reinforcing bar with epoxy into the building's slab to improve the floor diaphragm capability, allowing greater lateral loads to be transferred to the building's shear walls. As a final step, CFRP was wrapped around columns to improve their shear load capacity.

While different in scale, both of these projects required deep specialist knowledge of structures and also materials – combined with strong local knowledge. Like so many projects completed by BBR Network Members and showcased in CONNÆCT, these two buildings – and their various stakeholders – will now benefit from international expertise delivered locally.

1 Extensive upgrading work at OMV's new office building in New Plymouth included seismic strengthening.
2 Within the scope of their specialist design and construction project, BBR Contech strengthened the building's floor diaphragms over six levels.
3 The team bonded a total of 4,000m² of CFRP to the top of each floor slab and then applied 3,000 linear meters of CRFP anchorage to all termination points.
4 To ensure the building's compliance with New Zealand's Building Code, a range of seismic strengthening techniques were used by BBR Contech at Opus House in the Auckland suburb of Manukau.

TEAM & TECHNOLOGY

1 NEW PLYMOUTH

Developer – Volumex Nominees Limited
Architect – BOON
Consulting engineer – Tse Taranaki & Associates
Main contractor – Clelands Construction
Technology – MRR range
BBR Network Member – BBR Contech (New Zealand)

2 AUCKLAND

Developer – Analie Properties Limited
Structural engineer – Compusoft Engineering
Main contractor – BBR Contech
Technology – MRR range
BBR Network Member – BBR Contech (New Zealand)

Winning ways with CONA CMW

A bridge strengthening solution proposed – based on using the BBR VT CONA CMW post-tensioning anchorage – proved persuasive in New Zealand-based BBR Contech winning the contract. First, to understand the need for this project, we must travel back in time to the mid-1800s, when European settlers first arrived in New Zealand.

Waihue Bridge, north of Dargaville in Northland's Kaipara district of New Zealand, is one of several such structures originally built in the 1960s to 1970s and which now needs strengthening.

With the arrival of the new settlers, there was a huge drive to clear the land of abundant native forests and establish sheep, cattle and dairy farms. This was so strong that, less than 70 years later, some native tree species were threatened with extinction.

Successful strategy

In 1925 the Government took action, introducing financial incentives to create plantations of imported species. The fast-growing Radiata pine became the tree of choice and, by the 1960s, New Zealand had enough of the species to supply all its own domestic timber needs and secure the future of the remaining native forest. Today, New Zealand has around 10 million hectares of forests and, of these, eight million are native forest and 2.1 million plantation forest. Of the latter, 1.7 million hectares are productive and the forest products created from them are in the top three of New Zealand's export earners.

Logistical challenges

The transportation of logs from the forests to ports and other locations is a major logistical exercise, especially given the often narrow roads and bridges that trucks have to navigate. The issue has created a number of projects for BBR Contech over the years, with the latest being to strengthen Waihue Bridge. The structure was originally built in the 1960s to 1970s and is situated on a secondary road that crosses the Kaihu River north of Dargaville in Northland's Kaipara district.

The Kaipara District Council, which owns nine forests totaling 640 hectares, awarded the overall project to United Civil Construction who, in turn, awarded BBR Contech the contract to install external post-tensioning on the bridge. The purpose of the scheme was to increase its load capacity to accommodate "100% Class 1 and 50 MAX heavy vehicles".

Winning proposal

In its proposal for the work, BBR Contech suggested using BBR VT CONA CMW post-tensioning tendons, each made up of 16 x 15.2mm diameter strands. See also pages 82-85 for details of the testing undertaken by BBR Headquarters to verify the characteristics of these larger-than-standard size tendons. The proposal to use the CONA CMW system had a significant influence on the company winning the contract – as the large tendons would enable the team to work quickly and efficiently, while delivering a great result. The entire week-long process involved stressing and grouting the post-tensioned tendons, then lifting the bridge, installing bearings and grouting the bearing bases.

This was the first time that the CONA CMW system had been used in New Zealand and BBR Contech believes it could have great value in strengthening similar bridges of which many were built in New Zealand, around the middle of the 19th Century.

TEAM & TECHNOLOGY

Client – Kaipara District Council
Consulting engineer – RoadLab
Main contractor – United Civil Construction
Technology – BBR VT CONA CMW
BBR Network Member – BBR Contech (New Zealand)

Ringhals Nuclear Plant, Sweden PT tendon inspection

BBR tendons still strong after 45 years

The amazing strength of BBR tendons has been proven yet again during recent mandatory inspection control testing at Ringhals Nuclear Power Plant. Project Manager, Kristoffer Kalland, of BBR Network Member KB Spennteknikk AS describes the plant and provides a report on how the 2020 inspection was carried out.

1

Back in 1976, Swedish rock group ABBA was still topping the music charts, the Concorde aircraft made its first commercial flight and the Apple computing company had just been established. Meanwhile, Spennteknikk was installing the post-tensioning tendons for Sweden's Ringhals Nuclear Power Plant. In fact, during the 1970s, Spennteknikk carried out the post-tensioning work for eight nuclear power plants in Sweden and Finland – in many cases, we continue to inspect and maintain these massive post-tensioning installations.

The Ringhals story

The history of the Ringhals Nuclear Power Plant goes back to 1965 when land was acquired for the project on a peninsular in southern Sweden. Commercial operations started, with the second reactor, in 1975. In the years which followed, the other reactors were also connected to the grid and, today, around 20% of Sweden's electricity is generated by the Ringhals Plant.

Plant & installation overview

Ringhals has four reactors and is one of few nuclear power plants to have both boiling water and pressurized water reactors. Ringhals 2, 3 and 4 are pressurized water reactors and unbonded BBRV Wire post-tensioning tendons were installed in the containment walls of all three reactors. These tendons are subject to mandatory control inspections every five years. Ringhals 2 was retired from service and shut down in December 2019, but Ringhals 3 and 4 are still in operation.

The buildings are approximately 55m tall and each of the reactor containments have 548 BBRV tendons, each with 139 wires, which were installed horizontally, vertically and in the domed roofs.

The Spennteknikk team has followed this project right from the start when we supplied and installed all of the BBRV tendons. Since then, the company has had a continuous agreement for carrying out the five-yearly control inspections.

Lift-off testing

Our recent assignment consisted of a visual inspection and a lift-off test for different tendons at both R3 and R4 reactors. The tendons to be tested were selected randomly from all three types – horizontal, vertical and domed roof tendons. As we had anticipated, all of the tendons tested were still holding loads that were well above the prescribed norm-based values. After 45 years of service, that is quite some achievement – but one that we have come to expect after working with BBR technology for many decades.

2

BBR post-tensioning

The BBRV system – when combined with grease-filled ducts and in the hands of skilled engineers – allows for wire replacement. One wire in four totally different tendons was replaced. The old wires, together with grease samples, were sent to the Research Institutes of Sweden (RISE) for examination.

Most of the inspection control work was performed outdoors and two 60t movable platforms were installed on the roof of the containments specifically for this purpose. Each platform was manned by three engineers who operated the jacks and wire extraction tools. At Spennteknikk, we store and maintain a whole fleet of specialist equipment just for this regular task.

Unique data & amazing strength

The inspection control visits have been carried out regularly since the start-up of Ringhals in 1975. This has given Ringhals a unique series of samples and data on the behavior of pre-stressed steel over time – and also definitively proven that BBR post-tensioning technology is not only strong, but also that it is astonishingly durable.

1 Inspection work at the Ringhals Nuclear Power Plant required the installation of two 60t movable platforms on the roof of the containments.

2 The reactors at Ringhals are around 55m high and each containment was constructed using 548 BBRV tendons. Regular inspection control testing has proven that, even after 45 years' service, the tendons are maintaining loads well above prescribed norm values. Image courtesy of Mr Pontus Tossavainen, Ringhals AB.

TEAM & TECHNOLOGY

Owner – Ringhals AB
Technology – BBRV Wire
BBR Network Member – Spännteknik SLF AB (Sweden)

Research & development
BBR HiAm CONA stay cable system – Large scale testing & new developments

Indestructible & unique BBR stay cables

In the last 12 months, BBR's HiAm CONA stay cable system has been proven – through large scale axial fatigue and bending fatigue testing – not only to be fully compliant with the new *fib* Bulletin 89 guidelines, but also to be unbreakable. Dr. Haifeng Fan, Project Leader of BBR VT International's PT & Stay Cable Technologies Unit, describes not only the testing, but also introduces some important new developments for this technology which is unique in the market.

BBR stay cable systems were first developed and installed over 60 years ago. Since those early days, they have been further developed and refined to meet the increasing challenges and demands of the international market place. Today, the BBR HiAm CONA stay cable system is state-of-the-art – and our work over the past year has proven that it is the most durable stay cable technology anywhere on the planet and has increased the range of options available.

Axial fatigue testing to *fib* Bulletin 89

Back in June last year, a 91-strand BBR HiAm CONA stay cable passed an axial fatigue test – carried out in accordance with the new *fib* Bulletin 89 guidelines – with flying colors.

The test, at an independent laboratory, involved two million load cycles at a 200MPa fatigue stress range. The passing criteria allowed a maximum of 2% wire failures. 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.

BBR HiAm CONA

Axial fatigue test to *fib* Bulletin 89
Bending fatigue test to *fib* Bulletin 89
Passive stay pipe de-icing
New Adjustable Pin Connector
Fire protection testing

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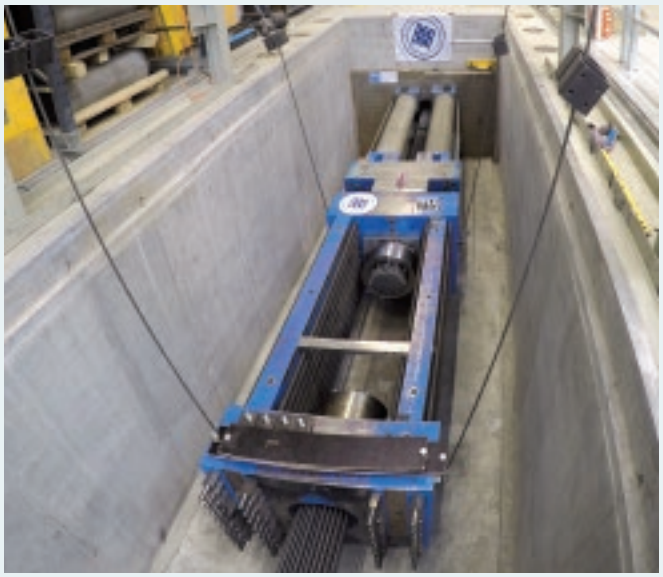

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Bending fatigue testing to *fib* Bulletin 89

A few weeks later, a 19-strand HiAm CONA stay cable was put to the test in a different independent laboratory. This time the HiAm CONA system 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. The superiority of the BBR HiAm CONA stay cable system was independently and conclusively proven.

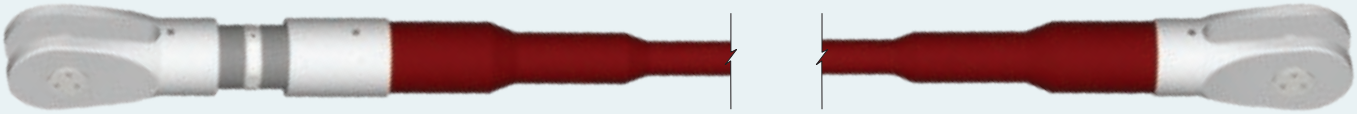
New & unique passive stay pipe de-icing

Accretions of ice and snow can be problematic for stay cables – not only do they present a danger to those nearby when frozen accumulations fall from the stay cables, but they can also cause 'ice galloping' – one of the phenomena which causes cable vibration. There is now a new and unique solution – BBR IceShield – which enhances user-safety on stay cable bridges by reducing snow and ice shedding from stay cables, as well as mitigating cable vibration. This innovative passive solution involves a thin, lightweight layer of a special transparent coating which can be applied to both new and existing stay cables without requiring any structural changes. Naturally, the durability and de-icing performance of this coating have been successfully tested. This included three main assessment criteria:

- De-icing performance – an ice adhesion test was carried out at controlled low temperatures. The ice adhesion reduction was validated by rigorous ice adhesion measurement – this coating outperformed other de-icing coatings in the market.
- High abrasion resistance – validated by a Taber abrasion test which is designed to simulate rubbing or wearing of coatings. This proved that this coating was only minimally affected by abrasion.
- Durability performance – here, the long-term durability of the coating was proven by carrying out tests such as repeated icing-de-icing cycles. To simulate rainwater erosion, a high pressure power wash test was performed. Beyond these qualities, BBR IceShield also offers the option of additional UV protection for stay pipes. UV-Con exposure tests were conducted – where test samples were repeatedly exposed to alternating cycles of UV light and condensing moisture at controlled temperatures. Again, all above-mentioned tests showed that the effects on this coating were minimal and would not alter the ultimate performance qualities of BBR IceShield. ›

Stressing side with adjustability

Fixed side



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On top of durability and de-icing performance, further advantages of BBR IceShield include simple application and maintenance – and, crucially, the dynamic performance (drag coefficient) of the original stay pipes can even be improved because of additional smoothness (thus less friction) provided by the BBR IceShield coating.
All this adds up to a solution which ensures public safety, reduces labor and energy costs and requires no interruption to traffic.

New generation BBR Pin Connector

The new generation BBR HiAm CONA Fixed and Adjustable Pin Connector features either a single- or double-ended pin. This is an attractive solution which optimizes both architectural and structural aspects of a stay cable. The HiAm CONA Adjustable Pin Connector is available up to size 19 and the fixed connector up to size 85 – larger sizes for both can be available upon request. Typical adjustments of +/-50mm and +/-100mm are achieved by a turnbuckle – higher adjustability for example +/-150mm, as well as intermediate scenarios, are also available upon request.
The design of the BBR HiAm CONA Adjustable Pin Connector incorporates a construction tolerance of +/-23mrad in the direction perpendicular to the clevis plate, which is higher than other solutions on the market. Furthermore the solution has been designed to offer flexibility for adapting to various cable stressing methods.
The new HiAm CONA Adjustable Pin Connector features enhanced corrosion protection which includes galvanization of all metallic components, filling with filler (flexible filler, wax or similar) inside various components, as well as coverage at different locations. An additional corrosion protection measure can be integrated for the adjustable parts – the turnbuckle and coupler – to enable easy de-stressing and re-stressing during the service life of the stay cable system.

BBR HiAm CONA fire protection system testing

The BBR HiAm CONA system, featuring BBR FireShield fire protection, offers a guaranteed performance even under various extreme conditions such as 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.
In the high-temperature strength test, the stable mechanical performance of all load-bearing components including wedges, anchorages and strands was experimentally verified at a minimum temperature of 300°C and sustained load of 60% GUTS – more stringent than the requirements in the recommendation. Even under such stringent conditions, the BBR HiAm CONA stay cable system guaranteed the strength for a much longer duration than the 30 minutes commonly required.
In the insulation system test, a full-scale BBR HiAm CONA stay cable tendon was successfully tested according to the same recommendation. In the test, the tendon, subjected to a hydrocarbon fire of 1,100°C, was protected by the BBR HiAm CONA fire protection system consisting of modular fire protection mat with hydrophobic feature and intumescent coating offering additional corrosion protection. With the help of the solid fire protection offered by the HiAm CONA BBR FireShield system, the temperature of the main tensile element at different locations remained below 300°C for a duration much longer than the 30 minutes commonly required. This test has been conducted to the severest testing scenario – that is, with the smallest allowable testing size (seven strand anchorage) in the recommendation. The heat transfer is much faster inside a smaller tendon due to its smaller mass when compared to larger sizes. Therefore, this proves that the BBR FireShield fire protection system complies to international

HiAm CONA FIRE PROTECTION SYSTEM

- MODULAR FIRE PROTECTION MAT IS ADAPTABLE FOR DIFFERENT TENDON SIZES
- HYDROPHOBIC LIGHTWEIGHT PROTECTION MAT PREVENTS WATER ABSORPTION
- INTUMESCENT COATING – ALSO PROVIDES CORROSION PROTECTION
- EASE OF INSTALLATION, INSPECTION, MAINTENANCE AND REPLACEMENT
- APPLICABLE FOR BOTH EXISTING & NEW STAY CABLES

1 Simply unbreakable – a 91-strand BBR HiAm CONA stay cable was subjected to axial fatigue testing to comply with *fib* Bulletin 89 and in the process proved its indestructibility. Pictured here are members of BBR's R&D team after setting up the test rig (left to right): Dr. Haifeng Fan, Dr. Xiaomeng Wang and Dr. Behzad Manshadi.
2 A 19-strand BBR HiAm CONA stay cable sailed through bending fatigue tests according to *fib* Bulletin 89 – not a single wire was broken and 100% GUTS was achieved in the subsequent static tensile test.
3 Axial fatigue testing to *fib* Bulletin 89 was successfully carried out on a 91-strand BBR HiAm CONA stay cable in an independent testing facility – not a single wire failed and 100% GUTS was achieved in the subsequent static tensile test.
4 The new and unique BBR IceShield enhances user safety on stay cable bridges by reducing snow and ice shedding from stay cables, as well as mitigating cable vibration.
5 The new generation BBR HiAm CONA double-ended pin connector.
6 Full-scale testing of a BBR HiAm CONA stay cable with BBR FireShield protection was carried out. This image shows the test specimen after 70 minutes at a temperature of 1,100°C.

6

recommendations for the full-size range of the BBR HiAm CONA stay cable system.
Last but not least, thanks to the simplicity of the fire protection system supported with innovative details, neither additional components, nor significant changes in the existing components, are required. The installation is also easy and possible for all sizes of both existing and new stay cables. Furthermore, it still permits access for the maintenance and inspection of protected components, such as deviators.
With these proven durability characteristics, features and configuration options, the BBR HiAm CONA system is quite simply the finest stay cable technology in the international market place.

Technical update BBR C Bar certification to EN 1090

Certified & strong

Certification to EN 1090 has been completed for the whole BBR C Bar system. This system features a fully-threaded high-strength cold-rolled steel alloy bar with excellent ductility and fatigue behavior.
BBR C Bars are suitable for application in structural bolting assemblies for preloaded and non-preloaded applications (PT bar) and as high strength rod or foundation bolts, especially for wind turbines. Features include:

- Four strength grades – 8.8, 9.8, 10.9 & 12.9.
- Diameters ranging from M36 to M68.
- Ultimate force range from 678-3727kN.
- Full system accessories, including anchor nut, bearing plate lock nut & coupler.
- Superior anti-corrosion capacity – and, as such, is extendable to incorporate double-layer corrosion protection.

Products certified as meeting the requirements of EN 1090 – the harmonized European standard covering fabricated structural steelwork – are marked with 'CE' to signify that they conform with current European standards in the respective category. Embraced within the standard are all processes – from procurement of raw materials, right through to final inspection and testing.
As with all BBR technologies, the BBR C Bar system has been designed and manufactured to rigorous standards and is subject to BBR's Factory Production Control (FPC) process, which is facilitated by BBR E-Trace, the bespoke online trading and quality platform.

Technical update BBR SDX Bar certification in Poland

National approval for BBR SDX Bar

The Polish National Technical Assessment process for the BBR SDX Bar System has been successfully completed. The assessment covers the whole system and range – T thread and R thread and all of the sizes; hollow bar plus all accessories. In one operation, the BBR SDX Bar System offers the option of simultaneously drilling, flushing the borehole (with water or air) and grouting – ensuring proper grout distribution along the whole tendon length. With a variety of different corrosion protection solutions and a wide range of drill bits covering various ground conditions, SDX Bars can be used for micropiling, anchoring and soil nailing applications. The BBR SDX Bar System is subject to BBR's stringent quality control processes and can be ordered via our online trading platform BBR E-Trace.

Research & development
BBR VT CONA CMW anchorage –
Solution for tanks & retrofitting projects

Large scale testing

The BBR VT CONA CMW anchorage for bonded or unbonded post-tensioning tendons with up to 16 strands has been successfully tested. Dr. Haifeng Fan, Project Leader of the PT & Stay Cable Technologies Unit at BBR VT International, explains the process adopted and the benefits of this technology.

The BBR VT CONA CMW anchorage offers an economical solution for certain types of tank or silo and, as shown on page 75, can also be a perfect solution for bridge strengthening operations. It requires no buttresses, no extra local anti-bursting reinforcement and half the number of anchorages – and thus stressing operations are reduced. In most cases, the anchorage may be entirely concealed within the standard structural thickness of a tank wall.

CONA CMW anchorage
The anchorage has been optimized for 15.7mm diameter, 1,860MPa strand. Standard tendon sizes are now from 2 to 16 strands – while larger sizes are available upon request. Accessories like protection caps and wedge retaining plates are also available.

Testing CONA CMW 1606 anchorage
Static testing of the CONA CMW anchorage, with 16 strands each of 0.6" diameter, simulating the real two-stage application was recently undertaken in an independent testing facility. The test was successfully carried out according to European Assessment Document 16 (EAD 160004-00-0301) guidelines. ›

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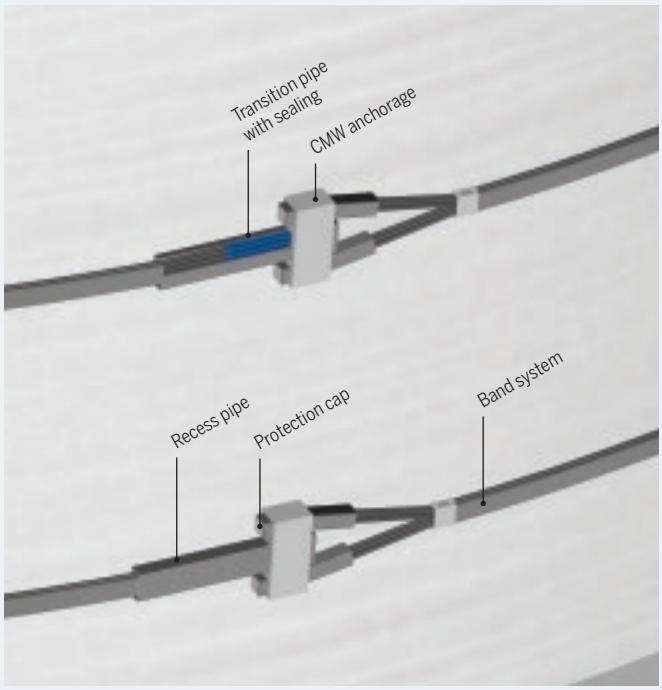

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Tank & silo construction with CONA CMW anchorages

The CONA CMW anchorage, as a robust post-tensioning system, is used in the construction of tanks and silos to increase concentric confinement in the structural wall and thus optimize the design in terms of concrete and steel reinforcement. On the other hand, using this system can offer the possibility of eliminating the buttresses which delivers economic benefits alongside the durability advantages – as confined concrete is free of cracks – and enhanced safety.

The CONA CMW anchorage can be combined with CONA CMI/CME systems to deliver the right solution, or used alone to form a 360° enveloping tendon around the tank or silo and self-anchored, where additional anchorages are completely eliminated.

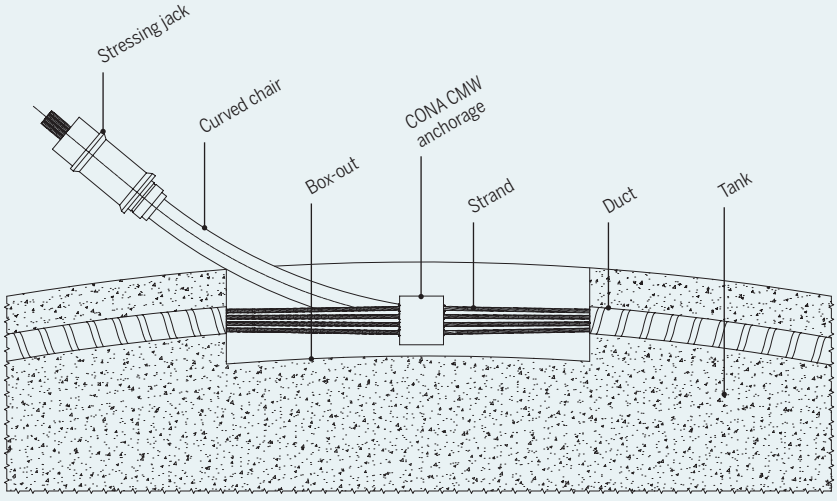
CONA CMW tendons are placed in corrugated or smooth tendon ducts, manufactured using either galvanized steel or plastic material. For bonded applications, the ducts are filled with high performance BBR grout. In addition, the CONA CMW anchorage is compatible with greased and HDPE-sheathed monostrands.

The tendon is directly stressed inside a box-out which, depending upon the access facilities, may be located on the inside or the outside of the concrete wall. Stressing operations require a curved stressing chair to be inserted between the anchor body and the jack. The adjacent graphic illustrates how the special curved chair enables the strands to be bent outwards from the box-out. After stressing, the box-outs are filled with concrete.

Tank & silo strengthening using CONA CMW anchorage with band system

The CONA CMW anchorage can also be used with a band system – such as that typically used with CONA CMB anchorages – to form a self-anchored external post-tensioning system and deliver a strong solution for tank repair or strengthening projects. The band system provides perfect wall-band interaction and can be deviated with a guide deviator and self-anchored at the CONA CMW anchorage. Double sheathing in the free length and recess pipes (and/or trumpets), together with transition pipes equipped with an innovative sealing system in the transition length, provide the highest corrosion protection for the whole tendon. The advantages of this solution are:

- The flat configuration of the band system offers a perfect seating for the tendon on the tank surface, which reduces contact pressure on the strands.
- It is a self-anchor system whereby the usage of permanent anchorage plates – normally requiring the fixing of massive steel components to the tank surface (in particular for big sizes) – is eliminated. Thus, a more aesthetically pleasing, lighter impression is created, while also reducing cost and installation work.
- Separate recess pipes and protection caps on the bands allow easy inspection and maintenance. Together with grease injection and double HDPE sheathing, ultimate corrosion protection can be achieved.



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Bridge/slab stressing with two passive anchorages using CONA CMW anchorage

In some bridge strengthening projects, the stressing is designed to be performed away from the end anchorages to allow it to be positioned as close to the slab/beam ends as possible, in order to enhance both flexure and shear strength in the beams. This requirement usually makes using a traditional anchorage impossible. In this case, a stressable coupler would be the ideal solution. Depending on the project, the stressing can be conducted by using either a multi-strand jack or a pair of mono-stand jacks to incrementally stress the coupler to the final desired stress in several steps. The coupler area can be placed completely in an HDPE tube and/or feature grout for corrosion protection.

In summary, use of the BBR VT CONA CMW anchorage provides an economical solution for tank or silo construction and strengthening, as well as for other applications where space is a prime consideration and time is of the essence.

BBR VT CONA CMW ANCHORAGE

- INTERNAL & EXTERNAL USE
- BONDED & UNBONDED APPLICATIONS
- NO BUTTRESSES REQUIRED
- NUMBER OF ANCHORAGES PER TENDON REDUCED
- STRESSING OPERATION PER TENDON DECREASED
- NO LOCAL ZONE REINFORCEMENT REQUIRED AROUND BOX-OUT
- APPLICABLE FOR STRENGTHENING APPLICATIONS COMBINED WITH CONA CMI/CME OR BAND SYSTEM
- OFFERS POSSIBILITY FOR TENDON STRESSING WITHOUT ACCESS TO SLAB/BEAM END ANCHORAGES

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1 The BBR VT CONA CMW anchorage is a strong and economical solution for tank construction and retrofitting projects.
2 Recent testing of a CONA CMW anchorage with 16 strands to EAD 016.
3 Visualization showing tank repair or strengthening using the BBR VT CONA CMW with band system.
4 Diagram showing how the special curved stressing chair enables strands to be bent out from the box-out.
5 Where time and space are prime considerations, the use of CONA CMW anchorages is an economical solution for bridge retrofit projects as shown here.

Research & development BBR VT Precast Segmental Coupler

State-of-the-art for segmental construction

The BBR VT Precast Segmental Coupler has now been successfully tested following the stringent requirements of *fib* Bulletin 75 and has completed European Technical Assessment (ETA), so will bear the all-important CE mark. This is a state-of-the-art coupler designed specifically with the segmental bridge construction industry in mind, therefore it incorporates strong, rugged, high performance materials together with user-friendliness and easy color-coded installation on site. It offers the highest corrosion protection level up to PL3 and includes PL2 applications. The available sizes on BBR E-Trace are ID 59, 76, 85, 100, 115, 130mm. Detailed information is presented in the BBR Plastic Ducts & Accessories Brochure.

Techniques First application of balanced lowering method

World première in Austria

The ultimate flexibility of BBR technology to support innovative construction techniques has been proven once again. The spectacular new 'balanced lowering method' for bridge construction, developed at the Technical University of Vienna (TU Wien), has been used for the first time on two motorway bridges in Austria. Daniel Cuerdo, BBR VT International's Head of Franchise Development, reveals some background details of the scheme and how local BBR Network Member KB VT provided expert post-tensioning services to this pioneering project.

As most readers will already know, there are many different methods of bridge construction – but this new technique is not only spectacular, it also offers many advantages. Normally, bridges are built horizontally, however use of the innovative balanced lowering method (Brückenklappverfahren) involves erection first in a vertical position and then rotation into a horizontal position – after which the girders are unfolded with the help of post-tensioning tendons.

Background to the story

This pioneering technique was the brainchild of Professor Johann Kollegger of the Institute of Structural Engineering at TU Wien. Patented in 2006, the new method was tested at 70% scale in 2010. Since then, a number of refinements to the process were made while the Professor and his team waited for an opportunity to deploy their technique on a live project.

The new method is especially suitable for crossings which feature high piers and span lengths of 50-250m and which are located in challenging terrain or across sensitive areas, because it avoids the use of extensive scaffolding and formwork. The time saving that can be achieved is significant and also the lower volumes of construction materials needed can make a positive impact on the construction budget. In fact, this has recently proven compelling for the construction of two bridges on the Fürstenfeld S7 Motorway project in south eastern Austria where savings of around 25% have been achieved.

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New bridge construction technique

The rotated girders of both bridges were 36m long, resulting in a span of 72m after lowering or 'unfolding'. Designed to be lightweight, the U-shaped hollow girders were made of thin-walled prefabricated concrete and each girder weighed approximately 54t. The girders are linked to compression struts by a movable mechanical joint.

On site, the girders use an auxiliary pier – in this case a tower crane – to act as a guide for their balanced lowering into their final positions on top of concrete piers. Lowering is achieved by the pushing apart, using hydraulic jacks, of the two compression struts while maintaining tension in the lowering strands. During the operation, the two girders unfold – along with the compression struts – until they reach their final horizontal position.

The gaps between the unfolded bridge and the abutments were spanned using suspended girders, resulting in a total length of approximately 105m in the case of Lahnbach Bridge and 116m for Lafnitz Bridge.

Crucial role for BBR post-tensioning

Four BBR VT CONA CME external tendons with monostrands were installed, guided over a saddle, inside the two hollow girders – thus joining the two girders together. The tendons were anchored at a joint close to each compression strut.

During the unfolding process – effectively a heavy lifting maneuver – KB VT used four compacted 165mm^2 diameter strands, as commonly used in the CONA CMB band system, for each of the two bridge girders. The lower ends were anchored on the girder and compression struts, while the upper ends of these strands were connected to lifting units on a platform at the top of the auxiliary pillar in order to transfer the tension forces during the lowering process. After the girders had been lowered, two 19-strand CONA CMI internal tendons, each up to 116m long, were installed. For lower friction, these tendons, running the full length of the girder, were placed in steel ducts which had already been cast into the girder edges. The new tendons were grouted and stressed, then the girders were concreted. Along with the CONA CME tendons installed earlier, all six tendons were then functioning as CONA CMI internal post-tensioning.

Temporary CONA CMM monostrand tendons were used to support the girder during concreting and before the CONA CMI tendons were finally stressed. These, plus the strands used for the lowering process, were later removed, along with the platform and crane.

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Bridge completion

For each of the two bridges, four such lowering processes were carried out side-by-side in order to achieve the necessary width for the motorway carriageway.

With the industry's continual drive for greater speed, safety and cost reduction, combined with lowered environmental impacts, Professor Kollegger and the entire project team have successfully harnessed existing skills, materials and technologies to deliver a wholly new and advantageous bridge construction method.

1 Girders and compression struts are installed over an auxiliary pillar, here a crane, which acts as a guide for their balanced lifting/lowering.
2 Four BBR VT CONA CME external tendons with monostrands were installed, guided over a saddle inside the two hollow girders – thus joining them together.
3 To maintain tension during the lifting/lowering process, two sets of four compacted 165mm^2 diameter strands, as commonly used in the CONA CMB band system, were used.
4 After the girders had been lowered, two 19-strand CONA CMI internal tendons, each up to 116m long, were installed. These work alongside the four CONA CME tendons which were used during the lowering procedure and now function as CONA CMI tendons.

Images courtesy of TU Wien.

Resilience, certainty & continuity

One of the key factors which influences the success of a business is ensuring sufficient resilience in its supply chain to cope with all eventualities. In the past 12 months, organizations around the world have faced the huge challenge of maintaining this important aspect of their commercial operations during the global Covid-19 coronavirus situation. Josef Lamprecht, Global Supply Chain Manager for BBR VT International presents an insight into a number of important issues – and the advantages that have been created for the BBR Network and their customers.

Supply chain management is all about delivering the right goods, to the right quality, at the right time and its role within a business is crucial – it can even be an element by which a company distinguishes itself from the competition. In fact, this is exactly what BBR VT International has achieved following the refocusing and building-out of BBR Global Supply Chain operations over recent years.

Growing the supply chain

With a global customer base, the challenge of ensuring continuity of supply becomes significant and includes many logistical considerations. The BBR strategy was to invest in creating a wider and thus more flexible supply chain network, by adopting a regional double-sourcing strategy to ensure greater redundancy and resilience. Additional investments have been made in further harnessing the benefits of digital technology to support processes and transactions.

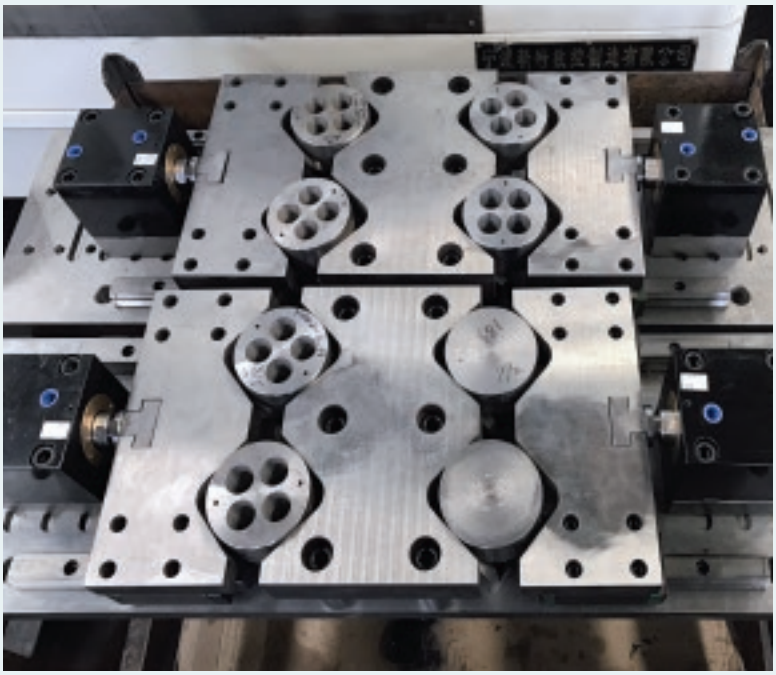
The journey to engage with a broader base of suppliers has required careful auditing of suitable manufacturers and then the building of trust with our new business partners. With a wide range of specialist construction engineering technologies in the BBR portfolio and our uncompromising approach to quality, it was important to identify companies which could offer the performance levels we required.

Trust is a key factor in any trading relationship and should be regarded as a two-way street – sometimes you have needs, sometimes your supplier has needs. The way you respond to these situations directly influences the durability and success of the business relationship. In a similar way, we also involve BBR Network Members in supply chain developments – in line with the BBR triangular business concept, outlined in CONNÆCT 2019. This continuous feedback loop ensures that everyone clearly understand needs and issues, so that we can all move forward, together, in the right direction.

Unique BBR quality assurance

One of the major innovations we have applied to managing quality in a supply chain context has been in the introduction of a 'PDI' – Pre-Delivery Inspection – process, a concept inspired by the automotive industry. Basically, this means that we carry out additional checks involving visual inspection, geometrical control, material verification and quality documentation after completion of any new production lot. This was designed to complement the existing Factory Production Control and Sample Testing programs, resulting in the BBR Extended Triple Stage Quality Control process which is unique anywhere in the industry. Another vital consideration is adding proper standardization as well as digitalization features to packaging, labeling, traceability of shipments, packages and components to ensure the right goods arrive at their destination in good shape and in the shortest possible time. This is particularly important in the case of products featuring additional corrosion protection, such as galvanizing or epoxy coating.

1 BBR has created a wider, more flexible supply chain network, while further harnessing the benefits of digital technology. Pictured here are anchor heads mounted on a table and clamped firmly in position to ensure engineering accuracy when inserted into the high tech CNC machine.
2 Global Supply Chain members must be able to meet BBR's uncompromising quality standards and offer performance levels required. Seen here is the manufacture of BBR SDX Bars.
3 The BBR Extended Triple Stage Quality Control procedure incorporates additional checks involving visual inspection, geometrical control, material verification and quality documentation after completion of any new production lot.



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Proprietary platform

All these great things can only work if you have a proper system behind them – a dependable system was needed. We needed to think like the Amazon of construction technology. We needed not only a front-end but also a back-end system too – where orders could be placed, manufacturing certificates could be uploaded and bar code technology could be used to ensure accuracy of deliveries.

This is why, some 12 years ago, we created and launched BBR E-Trace – our online trading and quality platform. Without doubt, this has been a major advantage for us.

BBR E-Trace was originally devised and built to the specifications and needs of the BBR Network and continues to evolve with feedback from its Members and to reflect additions to the product range. As well as facilitating online ordering and providing Factory Production Control, BBR E-Trace also reduces administration required – even generating the documentation necessary to satisfy various local customs regulations at delivery destinations.

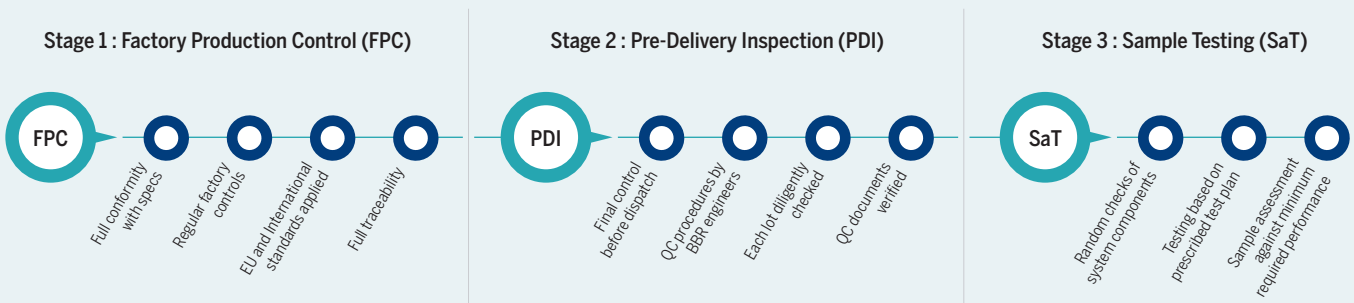
Over the years, BBR E-Trace has been massively extended and now offers greater functionality than ever before – this is an area in which we continue to invest.

Crisis management

The ultimate test for any system is a crisis. The resilience of the systems we had created was tested to the maximum by the global Covid-19 coronavirus outbreak last year. Thanks to accurate forecasting from BBR Network Members, we were able to optimize stock levels and then in addition create some further 'safety stock' as protection. The BBR Component Manufacturers rose to the challenge of manufacturing the various components needed to ensure that construction work could continue uninterrupted.

Today, it's no longer just about the products themselves, but also the way in which they are delivered. For example, the BBR Global Supply Chain has the capability – unrivaled in the construction industry – to have components ready for pick-up in just two to three working days. This is really where BBR Network Members now have a huge advantage because they can compete for short-notice projects. This is an excellent achievement, but it does not mean that we can now simply rest on our laurels. The whole BBR Global Supply Chain team is now firmly focused on adapting to encompass the many new features which will be added to the BBR technology portfolio and rolled out over the months ahead.

BBR Extended Triple Stage Quality Control procedure



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Thinking Aloud

Claude Néant, Founder of the BBR Network Member for France, ETIC & currently Civil Engineer Expert ETIC/ÆVIA – Group Eiffage

Innovation for a rapidly changing market

The two decades between 1960 and 1980 produced an abundance of all types of construction in Europe as a whole – and particularly in my native country France. Here, futuristic nuclear power developments, countless grand civil engineering works, as well as a whole range of industrial, commercial or leisure buildings, were realized with the use of post-tensioning techniques. It was a time of great construction activity fueled by the buoyant economies it was designed to support, however the specialist construction engineering toolbox was still incomplete and regulatory frameworks to ensure quality and safety were still in their infancy.

Even while the hectic construction activity was underway, engineering specialists were working to invent and develop external post-tensioning techniques. After many years' focus on perfecting corrosion protection systems, they arrived at a position where – should the need arise at some future stage – PT tendons could be removed and replaced. Back in those exciting days, imaginations were fertile, ambitions were high and the numerous construction projects gave each specialist the chance to develop and test a technology before regulation was introduced and led to the exclusion of the less sustainable newcomers. It was a similar situation with cable-stayed bridges where the first large-span structures were developed in this period.

Insufficient early regulatory frameworks

However, the levels of regulatory requirements and their implementation – without benchmarks – were not clearly established, so the various technologies which developed sometimes did not reach the expected performance levels.

Thus, half-a-century later, businesses such as those within the BBR Network have had to adapt urgently with rapid retraining and reskilling to address the need for repairing numerous prestressed structures which predominantly exhibited symptoms linked to corrosion in previous generation external post-tensioning installations.

Likewise, old buildings must now be converted and repurposed – holes need to be drilled and large penetrations in post-tensioned floors or walls need to be made. There was even a case where a leading nuclear power plant had to be shut down for a few weeks to allow construction engineers to dismantle heavily prestressed concrete structures in confined areas, with all the attendant health risks presented by the nuclear environment.

Unfortunately, the European Technical Approval (ETA) standards relating to the systems used were developed only for new build construction – and have not yet been adapted for application to technologies used in repair work or in modifications to existing post-tensioned structures.

Urgent rehabilitation interventions

Confronted with this appalling state of affairs, our technical services teams have had to create new techniques and ingenious devices to meet the specific demands of the market – often in an emergency, which is not conducive to ensuring the peace of mind and security that our staff deserve, and at our own expense. This was exactly the situation our team faced during

1 Echinghen Viaduct: Yet again, the team at ÆVIA had to innovate to deliver the required results for their customer. A special component was created to facilitate installation of the BBR anchorages without casting any new concrete sections. Even strand pushing had to be carried out in a novel way! (Read the feature in CONNÆCT 2020).

2 A9 Motorway: Pictured here is the project to strengthen the A9 Calcine and Pox Viaducts in France using BBR VT CONA CMB band tendons (see also CONNÆCT 2019). Here, for ease of handling and installation, the deviators were designed to be as lightweight as possible and were manufactured in two parts for bolting together on site.

3 Sharing ideas & realizing dreams: A frequent contributor to industry dialogues, Claude Néant and his colleagues participate regularly in such events to promote the sharing of knowledge – and sometimes their efforts are even recognized, such as with the 2018 BBR Best Photography Award, the author is seen here accepting the accolade.

4 Roissy Airport: One of many highly specialized interventions undertaken by ÆVIA was on the curved façade at Roissy, one of Paris' major airports. Before creating a large opening, CONA CMB tendons were installed on the surface of the concrete curve. However, the project also required the design and installation of a special clamp on each of the existing internal PT tendons before they could be cut.

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two recent contracts. One was a structural engineering project where we had to dismantle existing fully stressed external post-tensioning tendons and the other was part of a rehabilitation scheme for a large building where we had to take over work after concrete slabs had already been partially cut.

Sharing ideas & realizing dreams

A few years ago at the BBR Global Annual Conference in Rome, I can remember reflecting about how a robot should be designed to replace a technician for operations likely to be dangerous – such as the power cutting of a fully-loaded existing post-tensioning tendon, or to carry out dismantling operations in confined places such as nuclear power stations, prestressed viaduct box sections and so on. Since then, companies specializing in this area have developed new devices which may soon be available to help us.

Meanwhile, in our own field of expertise, we have seen the development of new technologies and techniques to address structural repair needs – which in Europe account for almost 30% of total infrastructure investment, a very significant and still growing segment of the market. Like other BBR Network Members, along with the opportunity to exchange information and share best practice with BBR Headquarters and, in fact, many colleagues around the world, we also have at our disposal some versatile post-tensioning systems with which to meet the demands of the market.

For example, CONA CMB is a perfect match when it comes to retrofitting because of its unique band which is used as a tensile element – it's a quick to apply, ready-to-use system and is easily adaptable to any strengthening project. Then, a couple of years ago, BBR launched the ultimate 'all-terrain' external post-tensioning system, the CONA CME grouted unbonded system with monostrands which, like CONA CMB, provides three layers of corrosion protection and allows for the lowest radii of curvature for use in almost any repair project. On top of this, there are electrically isolated and fully exchangeable solutions too.

The way forward

During the past year alone, we have seen the great capacity and capability of the BBR Headquarters team which is continuing to refine and develop products – even in the difficult working conditions to which we have all had to adapt. It seems the team has been working relentlessly to deliver even more technologies than ever before to improve many aspects of a construction project, as well as enabling the provision of completely customized one-off solutions to a highly-competitive market which will grow steadily in the coming years. This unprecedented momentum has created great anticipation – among BBR Network Members and the wider construction engineering community – for more stunning developments which we know are in the pipeline during the months ahead.

In these last months, we have experienced a terrible health crisis during which our technical companies were faced with long and financially painful production stoppages. Therefore, we all look forward to the launch of further new construction technologies, in particular those bearing the BBR trademark with all their usual embedded design excellence and quality, to allow us all to come back stronger in a rapidly changing market.

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.

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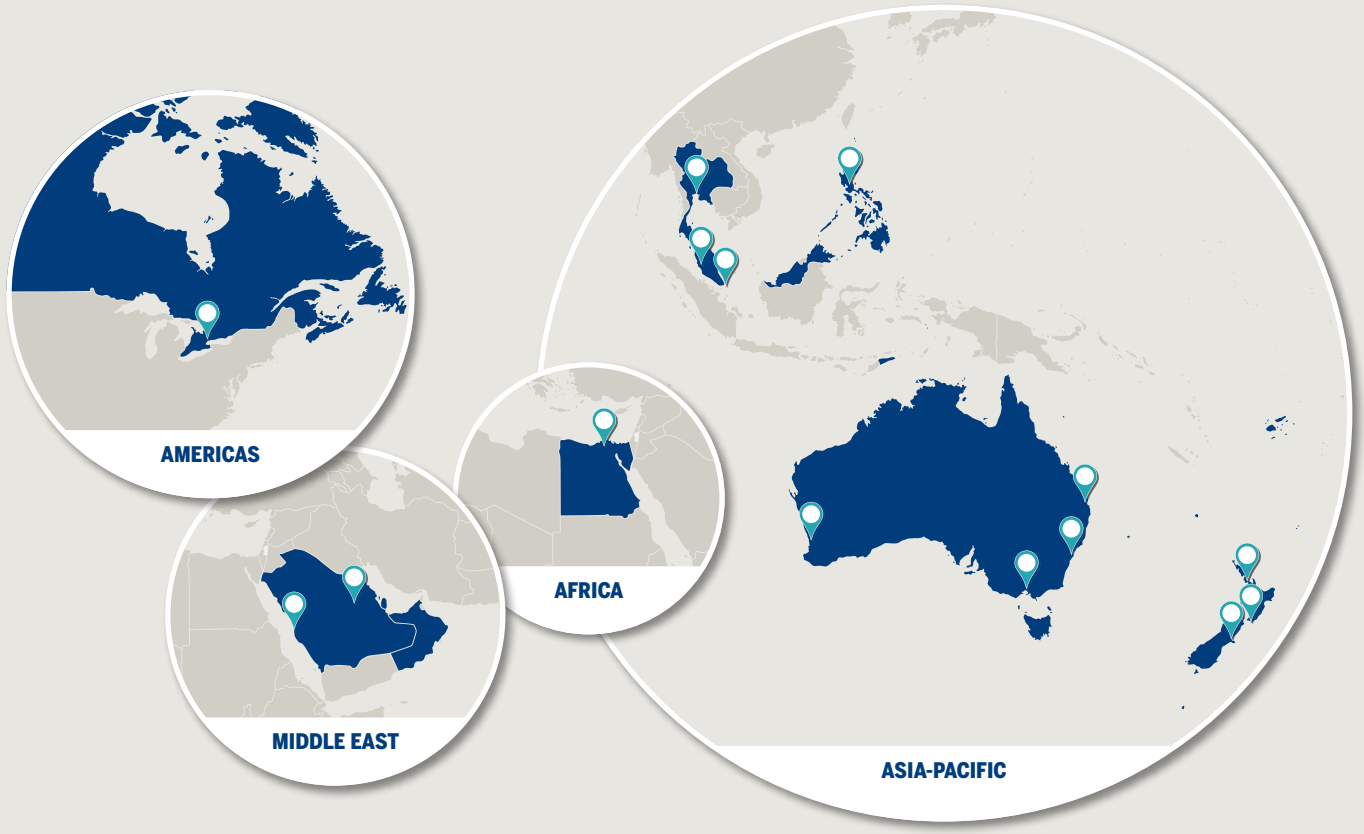

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