

CONNÆCT

THE MAGAZINE OF THE GLOBAL BBR NETWORK OF EXPERTS



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Selecting post-tensioning
technology strategies for tanks
and silos



Stahlton AG

Zurich, Switzerland

BBR VT CONA CMI for highway infrastructure

Making the neighborhood whole



A long-planned project to enclose part of the busy A1 highway in Zurich and crown it with a new greenway was only made possible with crossbeams and other structural concrete pre-tensioned with BBR cables. BBR Network Member Stahlton AG carried out the installation to ensure its integrity.

Schwamendingen in Zurich, Switzerland, has long been a divided city district. Between 1980 and 2022, as many as 120,000 vehicles a day passed along the A1 motorway, causing noise and pollution and separating neighbor from neighbor. An emerging project has already sent traffic into a tunnel reinforced by Stahlton AG-installed BBR pre-stressing technology, and there's a tunnel-top park to come.

The green dream team

The Schwamendingen enclosure project has been decades in the making, a hard-fought collaboration between local people, Switzerland's Federal Roads Office and the canton and city of Zurich.

The enclosure and park creation represents just part of the work on this stretch of the A1, totaling 1.7km. The highway's Schöneich Tunnel, now connected to the enclosure's east end, was simultaneously remodeled. The ceiling was thus closed off, and exhaust air was extracted and expelled into higher atmospheric layers via a new exhaust chimney. This significantly improved air quality in the neighborhood.

Work also included remodeling of the Saatenstrasse underpass through which neighbor can already visit neighbor by walking under the highway.

The complex project had to take account of continued traffic flow, a lack of space on-site, an underground tramway, and poor structural soil conditions. The length was divided into four sections and work scheduled in ten phases from 2018 to 2024, with multiple work items taking place concurrently at every length of the road. >

An historic project decades in the making is set to improve the lives of Schwamendingen's residents.



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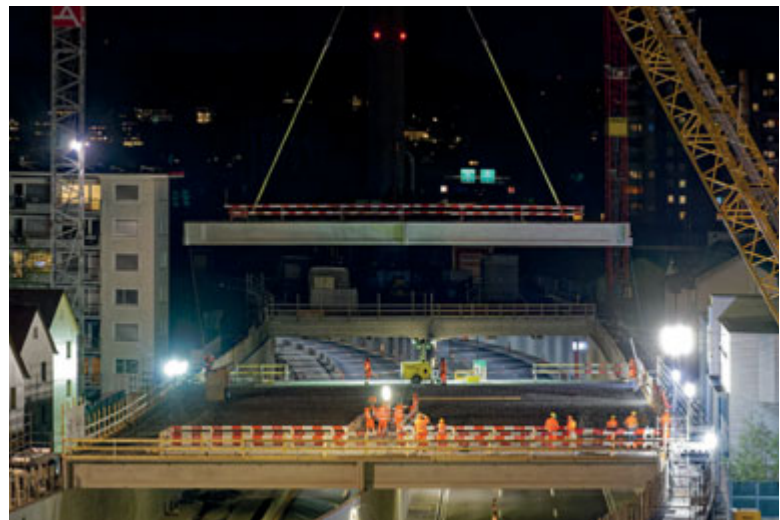
A box in a tunnel

Designs for the enclosure show a greenery-topped 7m-high and 30m-wide box. However, due to site-specific factors, the team needed to build it as an open cut tunnel, wrapping the roadway for 940m between the road's Aubrugg highway junction and the Schöneich Tunnel. The first of these factors was the Schwamendingen tram tunnel and station (serving lines seven and nine) which runs directly underneath the highway for 450m in the Schörl area. This could not be subjected to any additional loads. To protect it, the overhead roadway was strengthened with six, 70t pre-fabricated concrete crossbeams containing BBR VT CONA electrically isolated tendons (EIT).

The second issue was with the site conditions. The crossbeams are connected to walls as a support beam, strengthened with EITs. But the tendency of the subsoil to settle meant it needed to be supported on 1,250 piles driven 20m into the ground so the wall could support both the floor and roof of the tunnel – which would later support the park.

Keeping the peace

Constructing the complex enclosure in a limited area, and a support for the roadway larger than the existing space, proved additional site challenges. Some 19 buildings were partly or wholly demolished to accommodate works and storage before construction could start.



3

Building in the middle of a neighborhood of nearly 33,000 people demanded a strict noise reduction plan. The traffic needed to continue flowing and the Schöneich Tunnel was closed overnight during the installation of some elements while traffic was diverted.

Avoiding the trolley problem

The over-tramway section was one of the most complex parts of the build process. To divert the downward force of the enclosure on the 450m section above the tram, Stahlton AG tensioned six of the 234 concrete crossbeams with pre-stressing cables in two stages. The first work started in 2020 and the second in 2022.

- 2 Constructing the open cut tunnel early in the construction process. The suburb's residents were living very close to the construction site.
- 3 Constructing the roof of the enclosure over the A1 highway passing through Zurich's Schwamendingen, a project destined to finally link the populous suburb.
- 4 Supported by 20m piles, the post-tensioned tunnel walls support both the tunnel floor and roof.

TEAM & TECHNOLOGY

Client – Federal Office for Roads, Canton and City of Zurich

Architect – agps Architecture Ltd, Zurich

Engineer – Bänziger Partner AG, Zurich

Main contractor – ARGE EHS

PT design – Stahlton AG

Technology – BBR VT CONA CMI

BBR Network Member – Stahlton AG

The crossbeams all contain EIT from the European assessed BBR VT CONA system, internationally the most up-to-date and advanced multi-strand PT technology. Stahlton AG selected sizes 2206 and 3106, made up of between ten and 18 cables. The cables comprise more than 73,000kg of material.

All cables used in the Schörli area were coupled from the first to the second stage. This helped to mitigate the impact of friction on tension during stressing by creating a continuous and efficient load path for the applied forces.

The supporting wall was also designed to take EIT pre-stressing cables. The category C cables offer the maximum protection from the impact of water on the steel. Direct electrical contact between steel and surrounding concrete in the presence of an electrolyte can lead to accelerated corrosion. This 'galvanic corrosion' is reduced or eliminated by the EIT.

The pre-stressing cables are connected on both sides to a measuring cable, connected in sections to measuring boxes. This system provides real-time data on the performance of the roadway covering, assessing the effectiveness of the pre-stressing and the structural integrity of the system.

Structural support from end to end

The tramway was not the only part of the road enclosure that needed pre-stressing support. In 2022, the nearby Saatlenstrasse underpass was rebuilt as part of the project, requiring the use of more BBR VT CONA CMI EIT cables.

The section supporting the forest garden also took more pre-stressing technology although those were not EIT. Stahlton AG used the Dywidag WR 26.5 pre-stressed bar systems to introduce compressive forces into the concrete to account for the extra load of the trees and soil.

A green future for Schwamendingen

The most important part of the project, reducing the noise and pollution of the A1, was completed in 2022. Work to create the park and forest garden – Zurich's answer to New York City's High Line – was scheduled for September 2023. Once finished, it will be accessible via different entrances and connecting pathways, allowing Schwamendingen residents to meet over the motorway, this time in a green space. The green areas wrap around the side of the concrete body, partially covering it, taking away the hardness of the building and creating a dialogue between the new open space and the existing garden city.

From fumes to blooms

As far back as 1820, Schwamendingen was already an important location for transport – a village with 20 houses situated on the left bank of the Glatt river. Back then, more than 20 stagecoaches passed through daily. It became part of Zurich as District 12 in 1934 before hosting the four-lane A1 motorway, one of Switzerland's busiest routes, in 1982 as a feeder route to the A1.

As the Millenium approached, residents had had enough. They launched a popular initiative in March 1999, collecting 12,000 signatures to demand the partial covering of the motorway.

The initiative for enclosure prevailed after a comprehensive urban planning study in 2003, considering options such as a bridge and partial enclosure/partial lowering. In September 2006, Zurich's residents overwhelmingly supported the project, approving the loan proposal with 82.9% of the vote.

The green space on the enclosure is the project's most eye-catching feature for which Swiss landscape architecture firm Krebs und Herde tested plants for six years. The firm wanted to find out which species would survive on a thin layer of humus of 30-80cm and without irrigation.

Zurich city councilor Filippo Leutenegger, head of the civil engineering and waste disposal department, envisioned a 'prairie and savannah-like landscape.' After years of planning and political decisions, construction on the enclosure project began in 2019, supported by BBR Network Member Stahlton AG-installed BBR VT CONA pre-stressing technology. Completion is scheduled for 2024.



**Stahlton AG**

Zurich, Switzerland

BBR VT CONA CMI for exhibition hall

In it for the long hall

In 2022, Stahlton AG completed a road cover over the A1 motorway's Rosenberg Tunnel in St. Gallen, Switzerland, for the exhibition complex client, Olma Messen. Now the team would build their exhibition hall for 12,000 visitors over the top without it conflicting with the new construction.

The Olma Messen St. Gallen is the busiest conference center in eastern Switzerland, hosting trade fairs, congresses and cultural events.



Wanting to increase sales by a third from 30-40 million Swiss Francs over the next decade, the venue's owner needed to add extra capacity in the form of the new 9,000m² Olma Halle 1, recently named St.Galler Kantonalbank Hall. Stahlton AG constructed the post-tensioned cantilevered structural wall elements.

They've got it covered

The addition of the 150m by 90m St.Galler Kantonalbank Hall to the Olma Messen complex is just the latest Stahlton AG project in St. Gallen. Stahlton AG had previously installed

a cover on 186,65t of pre-stressed beams, incorporating the BBR VT CONA CMI EIT over the A1 motorway's Rosenberg Tunnel. This was achieved with the help of a 1,300t crawler crane. The 180m-long roof forms part of the base of the column-free hall.

The road covering meant the structural loads of the large space could not be transferred to the subsoil. Instead, the engineers designed a system in which wide-span, cantilevered reinforced concrete box girders were placed on 12 5m-wide cores now known as the 'elephant feet'.

Work started in 2021. The anthracite-gray cores were sited 40m apart around the perimeter of the emerging hall space to support the walls. First, the team cantilevered the wall structure 5.2m left and right. The 'ring' was closed with Stahlton AG's pre-stressed hollow box system with double walls. These are up to 50m long and high – enough to allow space for an almost 14m interior.

Using double walls increased structural stability compared to a single wall and reduced the concrete thickness required. The wall cavities provided space for emergency stairs and service access. Once the box system was in place, the space between the supports was closed off at ground level with a wooden and glazed facade and roofed after Stahlton AG finished on-site in 2023.

Boxing clever

To create the hollow box system, Stahlton AG used reinforced concrete box girders pre-stressed with a post-tensioned slab construction method. Using the European-approved BBR VT CONA CMI system, the team specified 164 anchorage points attached to cables of between eight and 19 strands. After tension was applied, around 20t of cement was injected into the tendons. This combination of systems and strand counts allowed for flexibility in the design of the support grid for the hall and the concrete thickness to be minimized.

The partially completed St.Galler Hall was used for the first time as part of the 80th OLMA Swiss Exhibition for Agriculture and Food in October 2023, welcoming 330,000 visitors. Full completion was scheduled for March 2024 with seating for 7,500 people and space for 4,800 diners or 12,000 on foot.

Another project successfully executed by Stahlton AG.



2

- 1 Aerial view of Olma Halle construction site, April 2023, showing how the road and tramway go under the structure.
- 2 Building the structural walls on the construction site.
- 3 Post-tensioned roof showing distinctive blue PT caps, and the close proximity of the Olma Halle's neighbors.

Images courtesy of Michael Huwiler.

TEAM & TECHNOLOGY

Owner/developer – Olma Halle St. Gallen Cooperative

Designer/architect – Ilg Santer Architects

Main contractor – Stutz AG

Engineer – Meichtry & Widmer

Technology – BBR VT CONA CMI

BBR Network Member – Stahlton AG



3

**Becomar**

Tanger, Morocco

BBR VT CONA CMF and BBR VT CONA CMM for school

Carefully taut

Becomar led a masterclass in speed, efficiency and professionalism when the team installed BBR's post-tensioning technology at a new facility in a thriving international school in Morocco.

International school provision in Morocco is expanding. This expansion can be seen at the Al Jabr International School in Tanger. The language learning institution needed a new premises for its trilingual (Arabic, French and English) students, and so it turned to Becomar.



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- 1 Young students at Morocco's newest international school will learn in three languages.
- 2 Becomar and BBR's post-tensioning helped create wide spans and remove the need for obstructive columns.

TEAM & TECHNOLOGY

Owner/developer – El Ghali Lyoubi Idrissi

Designer/architect – Benhayoune Kacem

Main contractor – GIDNA

Structural engineers – Bureau d'étude technique ben yahia

Technology – BBR VT CONA CMF and CMM

BBR Network Member – Becomar

Playtime is over

The Al Jabr International School offers students a 'redesigned linguistic approach' to education. The school boasts excellent laboratories, a refectory and kitchen, and art and music classrooms.

For Becomar, the project involved the construction of three different buildings for teaching departments and administration spaces, with a total surface area of 9660.7m². The biggest challenge for the team was the tight schedule for completion. Works had to be finalized before the August semester following a March start. Time was in short supply.

Becomar provided the team, materials and plant and equipment to install the floor slabs in the structures using BBR VT CONA CMF and CMM. Post-tensioning with BBR technology was preferable to classic reinforcement due to the short construction timeline. BBR post-tensioning helped to reduce delivery times and increase the structural integrity of the large, wide spaces under long spans between the columns and walls. The team also managed to cut the number of materials used and, in turn, overall project costs.

The project's outcome was a success. Becomar surely gets a gold star for its role in helping to complete the construction of the new premises by June 2023 in an incredible four-month window.



2


BBR Adria d.o.o.

Pula, Croatia

BBR VT CONA CMM for commercial property

Far-reaching business insight in Croatia

The Coworking Entrepreneurship Center in the Croatian city of Pula provides space for over 100 workers and features BBR post-tensioned ceiling slabs, panels and beams.

In recognizing the value of entrepreneurship to a country's growth, the European Regional Development Fund (ERDF) invested €2.4 million in the building, which opened in October 2023.



1

- 1 Preparing to pour the concrete slab on reinforcements. Ducts containing BBR VT CONA CMM unbonded cables.
- 2 Post-tensioned floor slabs enable the long spans between supporting pillars, opening-up the internal workspace.
- 3 The Coworking Entrepreneurship Center in Pula, Croatia, is post-tensioned with BBR VT CONA tech.

TEAM & TECHNOLOGY

Owner/developer – Istrian Development Agency, Ministry of Regional Development, city of Pula

Designer/architect – Atelier Bruno Juricic

Main contractor – Lavčević d.d.

Superstructure contractor/PT design – COIN, d.o.o., BBR Adria

Technology – BBR VT CONA CMM

BBR Network Member – BBR Adria



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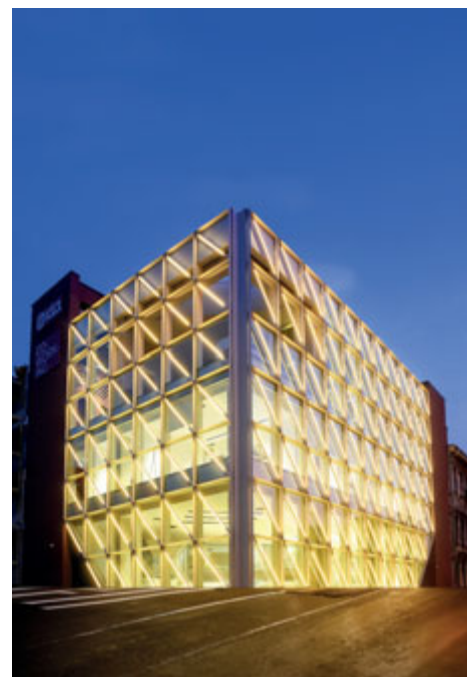
A center for enterprise and innovation for both the city and wider region, the building spans 1,500m². It is notable for its glass facade, enhanced with orthogonal and diagonal metal elements for pulsating night light effects.

Space to create

There are open spaces on the ground floor and mezzanine, dedicated offices for entrepreneurs on the second floor, and a large 120-seat hall with a terrace, 7m-high ceilings and a partial steel gallery on the third floor. The hall can be divided into two areas for concurrent events. BBR Adria provided post-tensioning (PT) for up to 15m spans. This eliminated the need for columns or obtrusive reinforcement elements, such as beams or girders. Between November 2022 and March 2023, the team manufactured monolithic PT ceiling panels, created formwork and installed the reinforcement, cables, concreting and tensioning.

The PT slabs are designed as a combination of 22cm-thick PT plates supported by 200/60cm shallow beams. Internal BBR VT CONA CMM O106 unbonded cables ensure structural integrity and flexibility.

So, when new ideas spark inside the co-working space, Croatia's entrepreneurs will have BBR Adria to thank.



3



BBR Saudi Arabia
Saudi Arabia
BBR VT CONA CMF for buildings

Redefining Saudi's urban landscape

BBR Saudi Arabia is extending the limits of what's possible in construction in Saudi Arabia.

BBR Saudi Arabia had already captured 60% of the region's post-tensioning market and expanded its workforce from 21 to 125 within five years of becoming a BBR Network Member (see CONNÆCT 2023, p34). Here, we cover four inspiring BBR Saudi Arabia projects that all feature the BBR VT CONA post-tensioning system. This technology was chosen for its efficient structural performance in large-span enclosures.



1 Jeddah Rose, Jeddah

This mixed-use building has two basement levels, a ground floor, and eight additional eight floors covering 35,600m². It also features a rooftop pool and spa, gym, restaurants, retail outlets, banquet halls and function rooms. Hard to miss is the viewing deck garden, which spirals at right angles from the 7th floor to the summit.

BBR Saudi Arabia delivered comprehensive PT design, supply and supervision services in an impressive 12-month timeframe. Post-tensioning helped to transfer beams, manage irregularities and accommodate inclined columns. The Jeddah Rose includes 150t of post-tensioning and 4,000 BBR VT CONA CMF S1 anchorages. The BBR VT CONA CMF multi-strand technology allows for post-tensioning in ultra-thin concrete cross-sections.

The design of the building's façade meant the team had to assess how much structural elements could deflect. The resulting structure is the embodiment of a successful collaboration between visionary design and precise execution.



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2 Northern Borders Museum, Arar

The Northern Border Museum at Arar was opened in 2007 to display the cultural and historical heritage of Saudi Arabia's Northern Borders Province. Now, an elaborate structure is being added: a pierced, sloping cuboid sunk into a raised platform.

This new space will reach around 40m at its highest point. The museum's development is an extreme engineering challenge, requiring the transfer of its 5,000t weight onto post-tensioned slabs.

The use of post-tensioning in walls and floors enables stiffening to resist lateral loads and the effects of gravity. The combined building engineering team must also account for temperature fluctuations resulting from irregularities, and stress concentrations at connections between the transfer slab and planted walls. Additionally, the building includes complex formwork. To address these challenges, BBR created a sophisticated solution using 4,000 BBR VT CONA CMF anchorages together weighing 150t. >



5

- 1 BBR technology is behind the unique shape and the creation of a spiraling roof garden in the Jeddah Rose. Reproduced with kind permission of PARALX.
- 2 PT technology allows the open, spacious internal spaces, such as the banqueting halls shown here. Using PT slabs during construction means faster build time with less materials. Reproduced with kind permission of PARALX.
- 3 The unique viewing deck gardens are a distinctive feature of the Jeddah Rose. Reproduced with kind permission of PARALX.
- 4 The National Border Museum is being developed to display the Northern Border Province's cultural heritage.
- 5 The cuboid structure weighs around 5,000t and is supported by PT slabs.



6

6 A distinctive addition to Riyadh's skyline, The Stage Center has large span internal spaces, enabled by PT.

7 BBR Saudi Arabia's team laying the PT tendons.

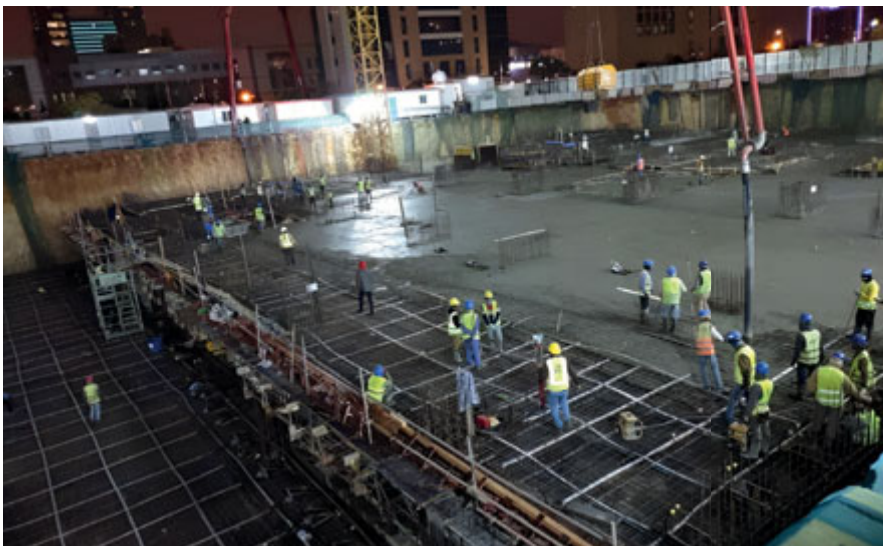
8 Over 6,000 BBR VT CONA CMF anchorages are being incorporated into Riyadh's Stage Center.

3 The Stage Center, Riyadh

The Stage Center is a 30-story mixed-use project, strategically located along King Fahd Road on an 8,250m² plot in Riyadh's Al Muruj neighborhood. To allow for the large spans, cantilevers and irregularities in the structural design, BBR Saudi Arabia employed around 6,000 BBR VT CONA CMF anchorages to hold flat tendons in post-tension supporting the 300t structure.

Post-tensioning saves on concrete costs through reducing the amount of material required, expands spans, and allows for cantilevered projections. The team's implementation of a smart solution underscores the project's commitment to cutting-edge construction methodologies.

The Stage Center is poised to redefine Riyadh's urban landscape, beautifully integrating form and function in high-rise architecture.



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4 STC Smart Square, Riyadh

Covering more than 121,000m², this smart development is spearheaded by AQALAT, a subdivision of telecoms company, stc. When complete, at the end of 2024, it will encompass 12 buildings including six towers and a new AI-enhanced hotel. The project in Riyadh City's Al Mursalat district was designed to showcase stc's digital technologies.

Smart Square is packed with physical devices connected to an intelligent building systems command-and-control center (CCC). This links core services, including lighting, power,

and water meters, pumps, heating, fire alarms, cooling, elevators, and access control systems. Critical instructions, notifications and alerts are automated. There is also a focus on sustainability with double-skin buildings, low carbon construction materials, and building energy efficiency.

BBR installed 560t of post-tensioning solutions within the flat slab on the project, helping it achieve completion with eight months. Around 11,000 BBR VT CONA CMF anchorages have been seamlessly integrated into the project.

9 STC Smart Square is an ambitious integrated development in the heart of Riyadh.

10 Viewed from a different perspective, the development includes several iconic structures, with open spaces for the building occupants.

TEAM & TECHNOLOGY

1 JEDDAH ROSE, JEDDAH

Owner/developer – Al Ameen Real Estate Company

Designer/architect – PARALX

Main contractor – Rafiq Kreidieh Contracting Co.

Superstructure contractor/PT design – BBR Saudi Arabia (PT Design)

Technology – BBR VT CONA CMF

BBR Network Member – BBR Saudi Arabia

2 NORTHERN BORDERS MUSEUM, ARAR

Owner/developer – Saudi Commission for Tourism and National Heritage

Designer/architect – Pace

Main contractor – Setco

Superstructure contractor/PT design – BBR Saudi Arabia (PT Design)

Technology – BBR VT CONA CMF

BBR Network Member – BBR Saudi Arabia

3 THE STAGE CENTER, RIYADH

Owner/developer – Al Saedan Real Estate Company

Designer/architect – The AJ Group

Main contractor – First Saudi Contracting Company

Engineering Consultant – The AJ Group

Superstructure contractor/PT design – BBR Saudi Arabia (PT Design)

Technology – BBR VT CONA CMF

BBR Network Member – BBR Saudi Arabia

4 STC SMART SQUARE, RIYADH

Owner/developer – AQALAT

Designer/architect – Saudi Consulting

Main contractor – BEC Arabia

Superstructure contractor/PT design – BBR Saudi Arabia (PT Design)

Technology – BBR VT CONA CMF

BBR Network Member – BBR Saudi Arabia