CONCRETEBETON

CEMENT & CONCRETE SA

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CEMENT & CONCRETE SA

FULTON Awards 2022

A CELEBRATION OF EXCELLENCE AND INNOVATION IN THE USE OF CONCRETE

Contents

Bryan Perrie, CEO & Fulton's judge

This message for the "Fulton Edition" of Concrete Beton is a celebration of the achievements of the Southern African concrete construction industry. The entries once again highlighted the ingenuity, innovation, and high-quality concrete construction that our industry has become known for.

Last years scheduled Fulton Awards were postponed as a result of Covid-19 which has had a devastating effect on our industry. However, while this has led to fewer entries than previous years, this has not resulted in a lowering of quality. On the contrary, all 24 entries were of a very high standard. The distribution of entries was as follows:

Gauteng	– 10	KZN	– 5
Western Cape	– 3	Northern Cape	– 2
Mpumalanga	– 1	North West	– 1
Eswatini	– 1	Namibia	– 1

While visiting all these projects was often exhausting as the visits took place over a six-week period and involved a number of flights, Covid-19 PCR testing and some 5 500 km of driving, my fellow judges, Stephen Humphries and Daniel van der Merwe, and I are very grateful to have had the opportunity to visit these exceptional projects. It was interesting to learn of the challenges that Covid-19 had presented including screening in up to 400 workers daily on very congested sites and having to deliver 150 m^3 of readymix concrete in 1 m^3 loads due to congestion in an inner-city location.

The majority of the project teams that hosted us were very enthusiastic about their projects and presented their projects in a very professional manner for which we, as the judges, would like to thank and congratulate them.

On behalf of my fellow judges, I would also like to thank Natasja Pols for her excellent handling of the logistics and the inevitable changes that were required, often at short notice.

The main opportunity to celebrate the excellence of the concrete construction industry will be at the gala awards ceremony on 10 June. The event will, for the first time, be live streamed to simultaneous events in the Western Cape and KZN. We look forward to bringing tribute to the teams that have constructed these amazing projects.

Yours in concrete
Bryan Perrie

OUR VISION
To be the unified voice of the cement and concrete industry in South Africa, defending and promoting the industry, driving growth and delivering shared value.

OUR MISSION
To create long term shared value and industry growth in South Africa. We do this by driving collaboration, skills development, innovation and the highest standards in sustainable cement and concrete materials and products.

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A celebration of excellence and innovation in the use of concrete!

Excellence is what this issue of Concrete Beton is all about. We showcase the 24 entries received for the 2022 Fulton Awards and by the time you read this, the winners and commendations would have been announced. As has been the case over the past 42 years, (the first Fulton awards being presented in 1980) Fulton's remain a highlight on the calendar of all involved: the project teams, the entrants, the judges, the organisers, the attendees and of course, the winners.

This issue of Concrete Beton is also a highlight on our publishing schedule as it is the first hybrid print/online edition since a decision was made to only publish Concrete Beton as an e-journal.

Because The Fulton Awards warrant well-deserved extended exposure for all the entries, this issue is being handed out at the three venues where the Fulton Dinners will be hosted: Gauteng, Western Cape and KwaZulu Natal. In addition, this issue is also being mailed to all our members and the electronic copy will, as always, be available on the Cement & Concrete SA website.

While we honour these special projects and the project teams, it is only appropriate to mention all those "behind the scenes" people who make the awards and everything that goes with it, a success.

The judges, who you get to know on page 8 in this issue, give their time and expertise gratis to visit every entered project. This means very early morning flights, late nights deliberating and comparing notes on the entries, PCR tests, and difficult decisions when presented with 24 outstanding projects to judge.

Various service providers bring their specialized and creative skills to the table to create an event, complimenting the world class entries: graphic designer, printers, webmaster, audio-visual and sound technicians, voice artist, administrative and catering staff of the western Cape, KwaZulu Natal and Gauteng venues, décor specialists, photographers, sponsors, advertisers, and the CCSA Branch Committees. Sadly, the originator of the Fulton Awards trophies, Damian Grivas, passed away in May.

Last but by no means least, a very special word of appreciation goes to Natasja Pols, Cement & Concrete SA's Membership & Events Manager, whose expert planning, coordination, and execution of the comprehensive Fulton Awards journey has resulted in a seamless experience for all involved.

Before we know, the process will start again next year with the call for entries for the 2024 Fulton Awards!

Remain motivated and inspired by our beautiful country, our buoyant cement and concrete industry and world class projects.

Hanlie

Hanlie Turner, Editor

The Fulton Awards

The 2022 Fulton Awards continues a tradition spanning more than four decades of recognising and honouring excellence and innovation in the use of concrete in southern Africa. Forty-two years have passed since the awards were first presented as a tribute to the late Dr. Sandy Fulton, the pioneer of the concrete industry in South Africa. Dr Fulton's visionary approaches to concrete technology, coupled with his contribution to the construction industry both in South Africa and internationally, led to his name becoming synonymous with quality, commitment, and distinctive concrete technology. It is fitting that both the seminal handbook, Fulton's Concrete Technology, and the Fulton Awards, are now curated by one consolidated body: Cement & Concrete SA.

Excellence in the design, use and innovation in concrete have always been the motivation for these prestigious awards, and the 24 projects that have been entered for this year's competition all clearly demonstrate what a unique and versatile building material concrete is.

There were five entry categories this year:

- Buildings up to R50 million project value
- Buildings greater than R50 million project value
- Infrastructure up to R100 million project value
- Infrastructure greater than R100 million project value
- Innovation & Invention in Concrete

Our judges have visited the site of each submission to fully evaluate the entries. This feature of the Fulton Awards elevates it above so many other awards where entries are judged solely based on a written submission. Entrants appreciate the opportunity to interact with the judges to demonstrate their pride in what they have achieved. The Awards are presented to the entire team that is responsible for producing the structure, or creating the development, including the owner/developer and all associated professionals.

As in the past, this year's entries compare favourably with world class projects.

Dr. Sandy Fulton

It is thus appropriate that as an International Partner of the American Concrete Institute, CCSA has nominated the winners in the five 2022 Fulton Award categories for the ACI Excellence in Concrete Construction Awards 2022, which honours exceptional concrete construction from around the world. Projects are recognized for the degree of innovation, complexity, achievement, and value that concrete has provided.

We thank all those involved in preparing submissions for their hard work and dedication, and particularly those members of the project teams who took the time to host our judges when they visited the various sites around the country and across the border.

The concrete industry in South Africa remains inspired by this showcase of world-class excellence.

aci Excellence in Concrete Construction Awards

Winners since 2001

FULTON Awards 2022

2001	Mozal Aluminium Smelter (Mozambique) Tokara Winery, Stellenbosch SA Jewish Museum, Cape Town Sandton Convention Centre, Sandton Finger Jetty, Richards Bay
2003	Maguga Dam, Swaziland Apartheid Museum, Johannesburg Westcliff Estate, Johannesburg Morland Millennium Bridge, Umhlanga Ridge
2005	Mohale Dam, Lesotho Constitutional Court, Johannesburg Nelson Mandela Bridge, Johannesburg Chapman's Peak, Cape Town
2007	Impala Platinum Mine No 16 Shaft, Rustenburg Athlone Soccer Stadium, Cape Town Bosmandam Road Pedestrian Bridge, Cape Town Mkomaas River Pedestrian Bridge, KwaZulu Natal Durban Harbour Services Tunnel, Durban
2009	Berg River Project, Franschhoek Soccer City Stadium, Soweto Moses Mabhida Stadium, Durban Cold Weather Concreting on Letseng Diamond Mine, Lesotho Concrete Retrofit Solutions at Van Der Kloof Dam Spillway Bridge
2011	Blackburn Pedestrian Bridge, Umhlanga Ubuntu Education Centre, Port Elizabeth Mountain House Roofs, Cape Town Hospital Bend Pre-Selection Scheme: New Overpass Bridges, Cape Town 15 Alice Lane Towers, Johannesburg
2013	De Hoop Dam, Steelpoort SANRAL Head Office, Pretoria Alexander Forbes, 11 West Street, Sandton The Podium, Pretoria
2015	Metolong Dam Pedestrian Bridge, Lesotho Umgeni Road Interchange, Durban Fairscape Precinct, Gaborone Chevron Project Core, Cape Town Gouda Wind Farm Precast Concrete Towers, Cape Town
2017	Mount Edgecombe Interchange, Durban Glen Crescent House, Cape Town Sol Plaatje University Library, Kimberley Zeitz MOCCA, Cape Town Integral Van Zyl Spruit Bridge, Trompsburg
2019	Maputo-Katembe Bridge and North Link Roads, Mozambique New Arch Bridge Over Olifants River, Western Cape Battery Park, V&A Waterfront, Cape Town 90A Bellamont, Umdloti House La Lucia, Durban Sal and Caldeira Phase2, Mozambique Norval Foundation, Steenberg, Cape Town

The Adjudication Panel

A distinctive of the Fulton Awards is the fact that the three judges, all well-known experts in their respective fields of concrete technology and application, visit the site of every entry to fully evaluate the concrete element of the project.

While visiting the sites, the judges have taken the attitude and passion of the team involved into account. The focus of judging for an award was on the material – concrete – and not on the project as a whole.

Thus, irrespective of category, the criteria for adjudication that the judges used were:

- Quality of concrete focusing on finish
- Sustainability – green building initiatives
- Inventive uses of concrete
- Overall aesthetic impact of the concrete aspects of the structure
- Quality of the concrete finish
- Standard of workmanship of the concrete
- Effect of the concrete on the architectural landscape and environment
- Involvement of local community, transformation, and health & safety initiatives

Introducing the judges: a materials specialist, a professional engineer, and a professional architect.

Bryan Perrie

Bryan Perrie

Bryan, CEO of Cement & Concrete SA, has both a BSc and MSc in Civil Engineering from Wits, and is a Registered Professional Engineer. He is also a Fellow of the South African Academy of Engineering, a member of the Institute of Concrete Technology in the UK and an Honorary Member of the International Society of Concrete Pavements.

He was a Board member of the Concrete Society, a Past President of the South Africa Road Federation and past Vice President of the International Society for Concrete Pavements and he chairs the South African Bureau of Standards Sub Committee of Cement, Concrete and Concrete products.

Bryan has authored and co-authored many publications dealing with concrete roads and floors.

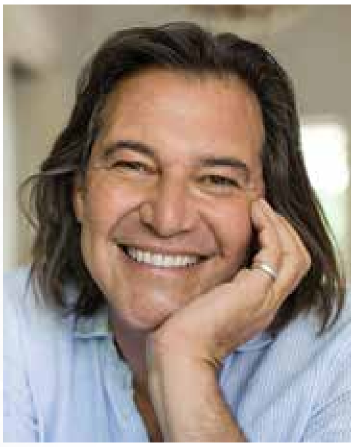
Stephen Humphries

Stephen Humphries

Stephen obtained a B Eng. and a B Eng. (Honours) degree from the University of Pretoria. He is registered as a Professional Engineer and he is a director of Nyeleti Consulting and head of the structural division, specialising in bridge engineering.

He has been extensively involved in several major bridge projects including strengthening and rehabilitation of existing bridges, as well as the design of new bridges. He co-authored many documents relating to bridge engineering.

Stephen was recognised as PPS Engineer of the Year by SAICE in their 2017 awards and currently serves as technical advisor to the South African Agrément board regarding the assessment of bridge-related products.



Daniel van der Merwe

Daniel van der Merwe

Daniel graduated in Architecture at the University of the Witwatersrand and is a registered professional architect. After his position as a lecturer at the University of Johannesburg, he joined the Cement and Concrete Institute heading the architectural concrete focus area.

He has been convener of the national ArchitectureZA initiative since its inception in 2010. He served on the South African Institute of Architects Board and its Mancom.

During his time at PPC as part of the specialist technical marketing and innovation division, he was chief curator of the Imaginarium, one of SA's largest art and design support platforms.

He is a past President of Gauteng Institute of Architects and currently serves on its Mancom.

Daniel is the founder member of LEAF Architects, a multi-disciplinary practice.

Winner

New Ashton Arch

PROJECT DESCRIPTION:

The original bridge over the Cogmanskloof River in Ashton, South Africa, was constructed in the 1930's. The original structural form was a five span, earth-filled arch type superstructure, allowing single lane vehicular traffic. The substructure consisted of wall type piers and abutments, with a skew angle of 50 degrees to the river. Around 1950 a substantial structural retro fitment was undertaken, modifying the superstructure to a cast in situ beam and slab configuration that maintained portions of the arch superstructure, including the arch-profile with related hydraulic opening configuration.

The client's brief involved improvement, to acceptable modern standards, of the flood resilience and overall safety of the road. Technical proposals were required to address the risk of frequent, and severe, flooding at the Cogmanskloof River Bridge in Ashton with due cognizance of the restrictive boundary conditions, most notably the large skew angle, high debris load as well as adjacent properties in the urban setting.

The design which was finally adopted consisted of a single span (110 m) concrete tied-arch solution with a deck suspended by stay cables which accommodates four traffic lanes and two walkways. This largely eliminated the possibility of debris build up and also provided the shallowest deck depth option (key considerations). Prestressed concrete was the material of choice since the primary load transfer mechanism of the tied-arch bridge is compression in the ribs and tension in the tie-beam. The constituent materials for concrete were readily available in the region and the durability of reinforced concrete requires very little maintenance. This construction method was labour intensive, thus providing working opportunities for non-skilled workers in the surrounding communities.

CONCRETE DESCRIPTION:

Crushed concrete from the demolition phase was incorporated within the engineered-fill layers and in the grouted rock fill layers.

A specially developed, high mobility 50/13 pumpable concrete mix was designed for casting the tie points. High-frequency compressed-air driven internal poker vibrators were used to consolidate the concrete. The pump tubes were gradually withdrawn as the concrete filled the element, and top shutters fitted incrementally for the elevated parts of the element. The remainder of the massive element was completed with the site-approved 50/20 concrete mix and placed mostly by pump and consolidated by regular internal poker vibrators.

The peak temperature within these massive elements were monitored via embedded sensors placed at the centre and outer edges of the massive pours.

Dolomitic limestone was selected as coarse aggregate owing to superior physical properties, lower coefficient of thermal expansion, and superior resistance to alkali-silica reaction. The fine aggregates consisted of a blend of crusher dust and river sand.

The 50 MPa high-strength concrete utilized for the main arch components; as well as sensitivity of the arch structural form to elastic stiffness, drying shrinkage and creep actions; and the design service life of 100 years, required that the mix design be subjected to a specialized laboratory testing regime.

Key specified parameters included limiting the maximum water content per m^3 of concrete (to limit drying shrinkage), minimum coarse aggregate contents (to maximise volumetric stability), and the use of the cementitious binder system comprising 30% fly ash.

The incorporation of fly ash in the binder system assisted with the durability properties, improved workability, and concrete finish, improved thermal performance, improved resistance to hot weather concreting, and improved the sustainability aspects of the project. The fly ash addition significantly reduced the effective carbon emissions and resulted in a lower embodied energy for the concrete.

Particular attention was required to conduct comprehensive cover to concrete testing on all the elements.

The four spring points are massive elements, requiring management of thermal performance of the concrete and associated cumulative strains. In these congested zones the critical mission was to ensure no cast cavities were formed. The deck of a concrete tied-arch bridge is prestressed to counter the thrust action of the arch ribs. This is achieved by placing concentric tendons in the tie-beams.

During tensioning of the first two tendons, significant under-extensions of up to 30% was recorded. The activity was halted, and careful investigation revealed that the method of installation had resulted in the entanglement of the individual strands. The faulty fully stressed tendons were destressed, discarded, and replaced with new strand. Strands that were installed in the remaining ducts were removed and re-installed by pull through method. Extensions measured after successful re-installation of strands were within 6% of the theoretical elongations, and were accepted.

The superstructure was completed adjacent to the existing road-alignment and was launched transversely into its final position onto the adjacent substructure; a first of this kind of construction in Africa.

JUDGES' CITATION:

The newly completed Ashton Arch is South Africa's first concrete tied-arch bridge constructed using a transverse launching method. The bridge replaces an existing multi-arch bridge, built in the 1930's, which did not fulfil its functional requirements, inter alia service life, width and hydraulic capacity, anymore.

The design which was finally adopted consisted of a single 110 m span concrete tied arch solution with a deck suspended by stay cables which accommodates four traffic lanes and two walkways. This largely eliminated the possibility of debris build up and provided the shallowest deck depth option.

Construction adjacent to existing bridge and transverse launching after completion minimized traffic disruption during construction.

Further, the tied-arch form expresses a visualisation of the flowing of forces through the arch ribs. The light hanger cables and slender structural members display transparency which is not excessively stimulating to the observer.

Extensive modelling and monitoring were carried out before and during construction and included various concrete mix designs.

The use of a transverse launching method for construction of a concrete tied-arch road bridge is a first in South Africa where more than 8000 tons of concrete and steel was moved over 24 m in less than 24 hours after several years of meticulous planning, design, and construction.

A further benefit of using concrete is that the method of construction is labour intensive, providing working opportunities for non-skilled workers in Ashton and surrounding communities.

A first and unique application of this bridge engineering technique for a concrete tied arch bridge in South Africa ensures that this is a deserved winner of the Fulton Award in the "Infrastructure over R100 million" category. ✦

TEAM

Location: Ashton, Western Cape
Categories Entered: Infrastructure > R100 Million Value | Innovation & Invention in Concrete
Submitted By: AECOM SA (Pty) Ltd
Client/Developer/Owner: Western Cape **Government:** Department of Transport and Public Works, Roads Branch
Project Manager/Principal Agent: AECOM SA (Pty) Ltd
Structural Designer: AECOM SA (Pty) Ltd
Main Contractor: Haw & Inglis Civil Engineering (Pty) Ltd
Specialist Sub-Contractor: Amsteele Systems (Pty) Ltd
Specialist Sub-Contractor: Allweld Marine & Industrial (Pty) Ltd
Specialist Sub-Contractor: Maffeis Engineering (Pty) Ltd
Specialist Sub-Contractor: Nyeleti Consulting (Pty) Ltd
Formwork Supplier: Form-Scaff (Pty) Ltd
Concrete Supplier: Afrimat Ready-mix Cape (Pty) Ltd

Commendation

Neckartal Dam

PROJECT DESCRIPTION:

The Neckartal Dam will provide water to the Karas Region in the dry southern part of Namibia. Due to the irregular, seasonal flowing of the Fish River and based on the construction and programming advantages, roller compacted concrete (RCC) was identified as the preferred material. This decision proved prudent as the main contractor had the expertise and techniques to mix and deliver such concrete in a hot desert area down into a steep ravine.

Because of the reservoir's footprint, is known colloquially as the Desert Dragon.

It is a 78.5 m high curved gravity concrete dam with a 518 m long crest, with a reservoir storage capacity of 857 million m³, extending over a 40 km² surface area at its full supply level.

Conventional concrete was most appropriate for some of the elements: the 87m high Inlet/Outlet Tower, the Spillway ogee crest; the primary framework for the Turbine House at the dam's base; and parts of the internal access galleries.

Neckartal Dam was constructed together with a downstream extraction works, pumping water to a Holding Dam to supply irrigation for the nearby farmland. For this phase, some 1.05 M cubic metres of concrete was required but, for the dam, some 844,000 m³ of RCC and approximately 110,000m³ of conventional concrete was used.

Special features and challenges included:

- the use of local aggregate sources;
- an intricate conveyor system to transport concrete down the steep rocky face of the valley which supplemented truck delivery;
- a cooling plant to cool the aggregates to achieve the correct placement temperature;
- the need for long-term concrete durability in the corrosive Fish River waters;
- optimization of wet well/conduit requirements, spillway performance and shape, using extensive physical model studies;
- optimization of the Inlet/Outlet Tower using Finite Element analyses; and
- long term monitoring using permanent instrumentation arrays and read out facilities.

CONCRETE DESCRIPTION:

Three different high-quality mixes were used: a higher cementitious content of RCC to create an impermeable upstream face and two lower cementitious RCC mixes for the body of the dam.

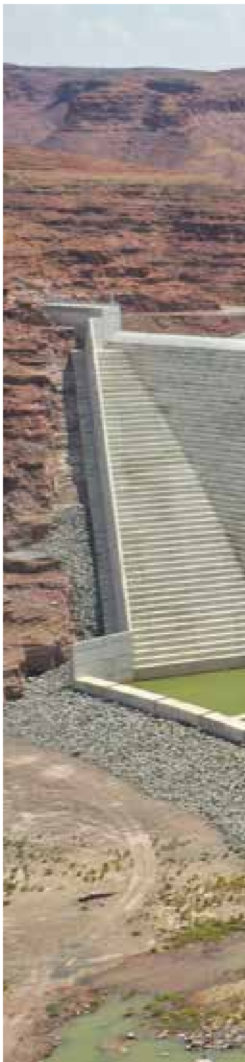
One hundred and sixteen thousand tons of cement were transported in two-ton bags from the nearest cement factory located at Otavi in northern Namibia. The closest fly ash sources were located in the highveld region of South Africa some 1 200 km away. Cementitious content was reduced to reduce the overall project cost. This was achieved using the latest developments in RCC technology to adopt mixes suited to such a remote arid site. RCC mixes were optimised for placing in hot dry temperatures, increasing the ratio of cold to hot joints and the potential for temperature induced cracking. This was mitigated using low cementitious mixes for the dam core, cooling the aggregates and, by using set retarders.

A cooling plant was erected to cool the coarse aggregate and the mixing water to ensure that the RCC placement temperature did not exceed 28°C.

Special care was taken to prepare the horizontal construction joints to ensure a monolithic watertight structure. Joint treatment was dependent on concrete age, with hot, warm, and cold joints receiving different treatment.

A 600t/hr crusher produced both the coarse and fine aggregate. The Contractor produced a total of 3.12 million tons of aggregate for the project over 33 months at an average of 94 800 tons per month. A large proportion of the RCC was transported from the batch plant to the dam using a 300m long conveyor belt, the rest by trucks.

The continuous uniform double curved shape for the spillway (Ogee) inherently posed some difficulties for constructability. Innovation was required to decrease the construction time whilst maintaining the accuracy of the constructed profile and avoiding honeycombing and blowhole formation on the finished Ogee surface. Construction was executed using controlled permeability formwork. This technique reduced the construction duration of the Ogee crest by a factor of more than two when compared to more conventional construction techniques.



The dam has close to three hundred electronic instruments to measure the behaviour of the structure during and after construction. There are 52 long based strain gauges to monitor the induced joint openings. There are 100 piezometers in the foundation to monitor the hydrostatic pressure under the dam. In addition to these gauges, there are temperature gauges, multiple head extensometers, strain gauges, tilt meters, 3 D joint movement gauges, survey targets, v-notch gauges and water level recorders. Instrument readings are recorded every few minutes and all are downloaded to a dedicated computer which can be accessed remotely over the internet.

To aid the monitoring capabilities of the site engineer's supervision, unmanned aerial vehicles (UAVs) were introduced for photographic surveys to develop accurate three-dimensional models that were used to monitor progress. Neckartal Dam was one of the first dams in the SADC region to apply this technology.

JUDGES' CITATION:

Neckartal Dam is one of the largest concrete structures constructed in southern Africa in recent years, primarily constructed of concrete with very few other construction materials. The project will supply bulk water to a new irrigation scheme located 40 km south-west of Keetmanshoop. It is the largest dam in Namibia and the eighth largest dam in southern Africa by storage volume.

Neckartal Dam is a 78.5 m high roller compacted concrete dam, with a crest length of 518m and a gross storage capacity of 857 million m³. Some 844 000 m³ of roller compacted concrete and approximately 110 000 m³ of conventional vibrated concrete were used to build the dam.

Managing logistics was challenging with the site located approximately 1 000 km from the nearest cement factory and 1 200 km from the closest fly ash sources. 116 000 tons of cement was required for the construction of Neckartal Dam. A key objective for the roller compacted concrete mix design was to reduce the cementitious content thereby reducing the overall project cost. This was achieved using low cementitious mixes for the dam core, cooling the aggregates and, by using retarders, reducing the set time. The low cementitious mixes contained either 85kg or 110kg of cementitious materials. A 3MW cooling plant was used to cool the coarse aggregate to achieve the placement temperature.

Meeting the challenges of constructing such a large project in such a remote location together with the innovations used earns a commendation in the category "Infrastructure over R100 million". ✦

TEAM

Location: Keetmanshoop, //Kharas Region, Namibia
Categories Entered: Infrastructure > R100 Million Value | Innovation & Invention in Concrete
Submitted By: Knight Piésold Consulting (Pty) Ltd
Client/Developer/Owner: Ministry of Agriculture, Water and Land Reform
Project Manager/Principal Agent: Knight Piésold Consulting (Pty) Ltd
Structural Designer: Knight Piésold Consulting (Pty) Ltd
Concrete Supplier: Salini Impregilo S.p.A.

Commendation

Vlakfontein Reservoir

PROJECT DESCRIPTION:

Construction of the 213.4 Mℓ Vlakfontein reservoir in Benoni, Gauteng, is well underway and is due for completion in the first half of 2023.

The circular post-tensioned reservoir is the country's largest cylindrical post-tensioned concrete reservoir.

The first three layers of the reservoir floor are a groundwater drainage and leak detection system. These layers are divided into 28 sections., each acting as a zone that will detect any possible future leaks with a drainage pipe running off to the sides of the detection system.

The permeable groundwater drainage system is constructed with three layers of 15 MPa no-fines concrete. 8000 m³ of no-fines concrete was first placed with a 50 mm thick layer of 9.5 mm stone mix, following a 245 mm layer of 19 mm size stone mix and lastly, a 125 mm layer of 26 mm size stone mix.

An 1800 m³ floor slab layer of 200 mm, 35 MPa concrete was then pumped in 13 sequenced pours of approximately 250 – 360 m³ each. The post-tensioned 45 MPa outer concrete walls are 11.8 m high, similar to a three-storey building. The walls are tapered from a thickness of 1 100 mm at the base to 300 mm at the top. The reservoir has an internal diameter of 154 m with 272 round reinforced 35 MPa concrete columns, 600 mm in diameter, to support the roof slab.

All reinforced concrete structures are water-retaining. The concrete mix design philosophy was to produce low shrinkage, durable, watertight concrete with as low heat of hydration as possible within the constraints of the required concrete strength.

This exceptional structure is a bold and overt statement of the strength and robustness of concrete.

CONCRETE DESCRIPTION:

Concrete pour sizes were as follows:

- Wall footing: Continuously reinforced and cast in 30 pours
- Floor slab: Continuously reinforced and cast in 13 pours,
- Wall: Continuously reinforced and post-tensioned, cast in 60 panels, each with 3 lifts (i.e., 180 panels total), maximum pour volume of panel with buttress = 48 m³
- Roof slab, continuously reinforced, cast in 41 pours, with maximum pour volume = 167 m³

Mix design objectives were to produce low shrinkage, durable, watertight concrete(s) with as low heat of hydration as possible within the constraints of required concrete strength. In the case of horizontal elements, prevention of plastic shrinkage cracking was paramount.

The Project Specification called for the cement to be extended with fly ash, since this lowers the drop in temperature from the hydration peak to ambient. It also required the use of dolomitic aggregates, and various water-reducing and water-proofing admixtures. The use of steel formwork (instead of timber) for the wall was specified to reduce the heat of hydration.

A 45 MPa/19 mm concrete was used for the reservoir wall and all other elements used a 35 MPa/19 mm mix.

Due to concerns regarding the large wall thickness, the first pour was done with 35% fly ash replacement. However, since the 28-day cube strength barely reached the specified 45 MPa, it was decided to reduce the fly ash to 30% and conduct 56-day cube tests, since strength gain during winter would be slower and 28-day cube results may not reach 45 MPa.

Eventually, summer and winter mixes for horizontal elements and columns were used, with the winter mixes containing less fly ash to reduce the initial and final setting time.

Measures were employed to limit the placing temperature of the concrete relating to the aggregates and a chiller plant was installed at the batch plant, where the mixing water was chilled to between 5 °C in the mornings and 7°C in the afternoons. Concreting generally started at 5:30 to 6:00 to further assist in this regard.

Early age protection was employed to minimise the risk of plastic shrinkage cracking in the large pours.

The underfloor drainage system consists of two separate parts, i.e., a groundwater drainage system and a leakage detection system. Both these layers employed unique layering of no-fines and other materials.

The reservoir wall slides on a continuous Teflon sliding bearing glued to the wall footing. In the wall, the bearing consists of one row of pairs of Teflon bearing pads, while in buttresses, it consists of two rows of pairs of Teflon bearing pads.

Care was be taken to prevent indentation of the joint former of the bearing due to concrete cover blocks supporting the wall reinforcement of the first pour. Specially made concrete cover blocks were, each with two sets of fixing wire, were used.

Cover blocks were not allowed to coincide with bearing pads, and cover block layouts for wall and buttress pours respectively were prepared. A wall section contained 147 cover blocks and a buttress section 274 cover blocks in a complicated arrangement.

There were a number of concrete types used, including 8000 m^3 of three different 15 MPa no-fines concretes in the underfloor drainage layer, 35 MPa concrete in the floor and columns and 45 MPa concrete in the walls.

The post-tensioned 45 MPa outer concrete walls are 11.8 m high, similar to a three-storey building. The walls are tapered from a thickness of 1 100 mm at the base to 300 mm at the top. It has an internal diameter of 154 m – the length of one and a half football fields - with 272 round reinforced 35 MPa concrete columns, 600 mm in diameter, to support the roof slab.

Extensive mix designs were carried out to reduce the shrinkage of the concrete to a minimum, maintaining the temperature of the concrete below 25 °C.

Care was taken to ensure good protection from drying and good curing. Measures included the use of fogging cannons and wrapping of concrete in plastic together with the use of wet geotextile.

This project is significant in its innovative use of concrete and for the large volume of concrete used. High ambient temperatures were a particular constraint, as were the strict slump requirements specified.

The challenge of building the country's largest cylindrical post-tensioned concrete reservoir and addressing all the challenges this presented, deserve a commendation in the category "Infrastructure greater than R100 million".

JUDGES' CITATION:

The Vlakfontein reservoir in Benoni, which will store 213.4 million litres of potable water, is the country's largest cylindrical post-tensioned concrete reservoir.

TEAM

Location: Benoni, Gauteng
Categories Entered: Infrastructure > R100 Million Value | Innovation & Invention in Concrete
Submitted By: Chryso SAF (Pty) Ltd
Client/Developer/Owner: Rand Water
Project Manager/Principal Agent: WBHO Construction (Pty) Ltd – NB – JV with Motheo Construction Group
Structural Designer: HGK Consulting cc
Concrete Supplier: PPC Ready-mix

Winner

Umhlatuzana River Bridge Modification

PROJECT DESCRIPTION:

Part of the five span, 150 m-long Seaward Road Bridge over the Umhlatuzana River collapsed, cutting off an important regional transport link and hampering the local economy.

It would have been relatively quick and easy to demolish and remove the whole structure, then rebuild it, especially under emergency provisions with a budget ready. The alternative of taking apart and reconstituting the bridge required negotiating many levels of uncertainty and risk.

However, a straightforward replacement would have come at the expense of riverside ecosystems, and wastefully discarded the portion of the bridge that was still intact.

Environmental sustainability considerations determined decisions all the way through the project, which involved numerous unusual challenges.

The salvaged spans had to be stabilised through extreme and ongoing variations in loading and displacement, as the damaged spans were cut away, blasted with explosives, then replaced, while suffering renewed flooding. Prestress couplers buried deep in existing reinforced concrete had to be meticulously quarried out and exposed, so they could be safely reused to connect the replacement spans. When it was discovered that those couplers weren't compatible with modern components, the components had to be custom-modified and then tested. A precisely limited prestress force had to be applied to the new deck spans, to account for the age-related differences in concrete behaviour, and increase in length, of the reconfigured bridge.

The success of this project clearly demonstrates the flexibility of prestressed concrete as a construction system. Prestressed elements can be re-used if a structure is damaged or when major modifications are required, making it much more modular than is usually assumed. It proves that decision-makers should consider modifying the length of continuous multi-span bridges rather than rebuilding them, particularly when adding additional lanes below. This is in the interests of both economy and environmental sustainability.

CONCRETE DESCRIPTION:

Major challenges presented in this project necessitated innovative and clear solutions to successfully carry out the planned modification.

Environmental sustainability was addressed by salvaging and reusing undamaged portions of a concrete bridge, avoiding disturbance of a sensitive natural environment, and recycling all 620 m^3 of material from components that were damaged to create G7 material for use in layerworks and abutment fill.

The collapsed portion of bridge deck needed to be removed without causing the remaining portion to collapse, while posing a major safety risk for workers. Temporary stability was achieved with the urgent installation of ultra-heavy-duty 1 000 kN props on either side of each pier.

The deck was then cut apart 2 metres away from the ten critical prestress couplers with a wire saw. The couplers were carefully exposed by hand, with sharpened chisels to avoid any microcracking. The existing steel reinforcement was also treated with care, so new rebar could be spliced onto it.

The damaged deck was broken up using chemical explosives.

The portion to be demolished was stabilised with lightweight, sacrificial falsework props. With the deck wrapped in geofabric to prevent flying debris, a sequence of closely timed blasts created a safe, predictable collapse.

The VSL fittings from 1979 were not compatible with the prestress systems available today. The only option was to modify the modern swages to fit and test the results in a laboratory.

Two factors complicated the prestress analysis and design: because the original bridge is 40 years old, its concrete behaves very differently to new concrete when tensioned and the bridge had to be lengthened by 4 metres so the piles for the new abutment would not clash with the original driven piles, which remained in the ground. The increased length changed the loading and stiffness of the end span.

The effect of lengthening the bridge was for the end span to move from a class 2 prestress condition to a class 3 partially prestressed condition under full traffic loading, CEMENT & CONCRETE SA FULTON Awards 2022

The concrete mix for the deck was a 45 MPa pump mix. The mix for the new abutment and pier was a standard 30 MPa mix. Both mixes used a CEM II A-M(V-L) 42.5R cement, with 20% GGBS added, as well as a water-reducing admixture.

The use of some larger 28 mm coarse aggregate was assumed to reduce shrinkage in the deck without compromising penetration and consolidation in areas of densely congested reinforcing steel.

For piling, a standard 30 MPa grout mix was used with a CEM III A cement with 50% GGBS, medium river sand for the fine aggregate, and a concrete admixture.

JUDGES' CITATION:

This project in eThekwini demonstrated the surprising extent to which a large, continuous, prestressed concrete bridge could be partially dismantled, modified from the original design, and rebuilt. Major challenges included:

- Supporting an unusually unstable structure through extreme and ongoing variations in loading and displacement
- Demolishing deck spans of a concrete bridge suspended over a sensitive waterway
- Reuse of prestress couplers by removing reinforced concrete meticulously and carefully to expose deeply buried couplers, so they could be safely reused to connect the new deck section to the retained deck section.
- Custom modifying and testing prestress components
- Applying a precisely limited prestress force to the new deck spans, to account for the age-related differences in concrete behaviour, and increase in length, of the reconfigured bridge.

TEAM

Location: Durban, KwaZulu-Natal
Categories Entered: Infrastructure up to R100 Million Value | Innovation and Invention in Concrete
Submitted By: eThekwini Municipality, Roads Provision Department, Structures Branch
Client/Developer/Owner: eThekwini Municipality – Engineering Unit
Project Manager/Principal Agent: eThekwini Municipality, Roads Provision Department, Structures Branch
Structural Designer: eThekwini Municipality, Roads Provision Department, Structures Branch
Specialist Sub-Contractor: ICON Construction (Pty) Ltd
Specialist Sub-Contractor: Bloc Contractors
Specialist Sub-Contractor: Megapile
Specialist Sub-Contractor: Hlanganani Civils
Specialist Sub-Contractor: Post Tensioning & Structural Solutions (Pty) Ltd
Concrete Supplier: AfriSam South Africa (Pty) Ltd

The chosen solution was complex but left the existing footprint of the bridge for most of the watercourse unchanged, saved 850 m^3 of concrete in the existing bridge, and avoided a larger demolition that would have destroyed nearby trees with nesting birds. All 620 m^3 of demolished reinforced concrete was recycled in layerworks and abutment fill.

Overcoming the above challenges with a unique solution earns this project a Fulton Award in the "Infrastructure under R100 million" category.

Commendation

Essex Terrace / M13 Bridge Modification

PROJECT DESCRIPTION:

The existing Essex Terrace underpass was built in 1971. Significant urban development in the neighbourhood urgently requiring additional lane capacity through the surrounding interchange. Rather than building a new bridge, it was decided to add an additional simply-supported deck span. The existing bridge abutments comprised large reinforced concrete walls, which allow for significant structural modification. The wingwalls and counterforts were removed, and the resulting concrete element could be carefully transformed into an unexpectedly elegant pier by the specialist concrete contractor.

It was critical to minimise lane closures on the overlying M13 highway, so a hybrid top-down, build-and-dig-out deck construction methodology was used. Preparation for deck construction was minimised by initially only constructing the vertical load-carrying components of the abutment and using ultra-lightweight piles that carried no horizontal or bending load. Once the deck was complete and carrying traffic, further excavation could continue below, and a soil nail lateral support system was installed. The sprayed concrete of the soil nail system was troweled smooth to mimic an off-shutter concrete finish. The resulting highly optimised abutment massively reduced the amount of material in construction and excavation.

An experimental approach was also to remove the bridge joints and replace them with fibreglass reinforcing grids in the asphalt layers.

The project deliberately did not match the new deck section to all aspects of the existing deck section. The existing deck is a shallow multi-cell box girder, while the new deck is a lightweight triple T-beam design. The result is a concrete structure that lets its complex history be seen.

This project used several experimental solutions to address aesthetic and sustainability concerns.

CONCRETE DESCRIPTION:

The sprayed concrete in the soil nailing system was shaped directly by hand to give a 'trowel-finish'. The layers of light mesh in the sprayed concrete are assumed to make it less rigid than a conventional concrete wall, allowing it some capacity to flex and accommodate thermal movements, thus limiting cracking.

It was decided to experiment with removing the expansion joint nosings on both the new and old decks. The tops of the expansion joints were simply sealed off, and fibreglass reinforcing grids installed between the overlying asphalt layers to distribute the strains of deck expansion and contraction. Ongoing monitoring of the performance at the different joints will be necessary, and there may still be a need for remedial work in the future. Removing the joints provides a pleasantly smooth riding surface.

The two spans of this bridge have unmistakably different deck cross-sections. The old deck mostly has a single uniform soffit, while the new deck is comprised of T-beams with multiple soffit surfaces. This contrast is moderated by the sections having the same depth, and the outer cantilevers having the same width, creating continuity.

The 'top-down' construction sequence was as follows: first, those components of the new abutment designed to carry vertical load, together with the conversion of the old abutment to a pier, then the deck, then the lower portions of the new abutment designed to carry lateral loads.

The new West abutment was a combined bearing seat and pilecap. Complex geometry of the overlying road, with its steep crossfall, combined with the awkward shape of the upstands underneath the deck cantilevers made the setting out difficult.

For the conversion of the existing West abutment to a pier, the contractor excavated locally and installed concrete columns which were doweled into the existing abutment base and walls. The design of these columns was kept simple to minimise construction time. A lower strength concrete mix was used here to match the concrete in the old abutment and reduce shrinkage effects. Specifications for connecting new concrete to old were carefully adhered to, particularly ensuring the existing wall was water damped for 24 hours.

The straightforward reinforcing steel for the deck allowed less experienced steel-fixing subcontractors to be used, broadening opportunities for job creation and supporting local businesses.

To allow access for poker vibrators in the highly rebar congested diaphragms, some of the lacing bars in the top mat were only placed after the beams had been filled up with concrete.

Lateral support was provided with grouted anchors and a single layer of mesh and sprayed concrete. The lateral support is flexible to a point and was also allowed to settle slightly by doing a larger area of finishing coat than the initial area.

A variety of concrete mixes were used for the different elements to accommodate grouting, low shrinkage, pumpability and sprayed concrete requirements.

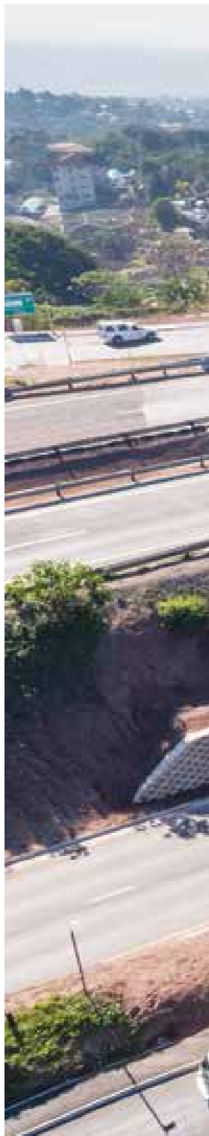
JUDGES' CITATION:

This project used several experimental solutions to support a design rationale that directly addressed sustainability concerns. It also involved some boldly progressive and effective responses to the aesthetic challenges associated with modification of an existing structure.

The new bridge span was built using a hybrid top-down, build-and-dig-out methodology, as an experimental project aimed to investigate the viability of this construction method in the future.

The new abutment is extremely mini-malist, being comprised of lightweight piles and soil nails rather than the conventional heavily reinforced concrete abutments which have much higher financial, time and sustainability costs.

The primary reason for the top-down approach was to minimise the time-consuming installation and subsequent demolition of expensive and wasteful temporary lateral support between the



two carriageways, while the first deck was being constructed. This temporary lateral support was necessary because the two carriageways' decks needed to be built separately, one at a time, so one of them could always remain open to reduce traffic disruption.

This project demonstrates the versatility of concrete for use in radically different construction systems. The result is a structure that lets its complex history be seen, but without being ill-fitting and ugly. It becomes a bridge with a story, and an organic life of its own. This also ties in with the agile look created by the raked bullnoses.

The successful experimental solutions applied on this project earn it a commendation in the "Infrastructure less than R100 M" category.

TEAM

Location: Durban, KwaZulu-Natal
Categories Entered: Infrastructure up to R100 Million Value | Innovation and Invention in Concrete
Submitted By: EMPA Structures / eThekwini Municipality, Roads Provision Department, Structures Branch
Client/Developer/Owner: eThekwini Municipality – eThekwini Transport Authority (ETA)
Project Manager/Principal Agent: eThekwini Municipality, Roads Provision Department
Structural Designer: eThekwini Municipality, Roads Provision Department, Structures Branch
Specialist Sub-Contractor: EMPA Structures (Pty) Ltd
Concrete Supplier: Lafarge South Africa (Pty) Ltd

Winner

Jewel City – The Onyx

PROJECT DESCRIPTION:

The new Jewel City precinct is situated within the former heart of the diamond and precious metals trade - the city of Johannesburg. This bustling mixed-use area for residents, retailers and businesses is positioned as an ideal precinct for living and leisure, shopping and pleasure.

Jewel City's residential apartments provide various options to meet all needs in the safest new precinct in the city. Direct access to the best amenities, including shopping, restaurants, and green outdoor spaces. The arrival of this impressive new precinct presents a fresh opportunity for young professionals who work in the city to finally live closer to work and leave the dreaded commute behind! Jewel City is located in Maboneng, Johannesburg, with secure parking and great access to public transport.

The development of this ambitious new precinct has a vision to completely transform the formerly entirely closed-off bunker-like complex that was once the heart of South Africa's jewels and minerals trade.

The Onyx houses residential apartments (629 units) over 11 levels, with ground floor retail and parking and an additional semi-basement parking level, adding up to a total gross leasable area of 21 703 m².

CONCRETE DESCRIPTION

The aesthetic approach of The Onyx draws inspiration from the industrial presence of the surrounding context and celebrates the simplicity of warehouse architecture.

A concrete-framed structure with concrete bearing walls, makes up the main load bearing elements of this building. Transfer beams enable vertical loads to be transferred at retail/parking level to columns, allowing for a more open and flexible ground floor space. This load bearing system advantageously allows for repeatability during construction and one-way spanning slabs, resulting in a very efficient slab design.

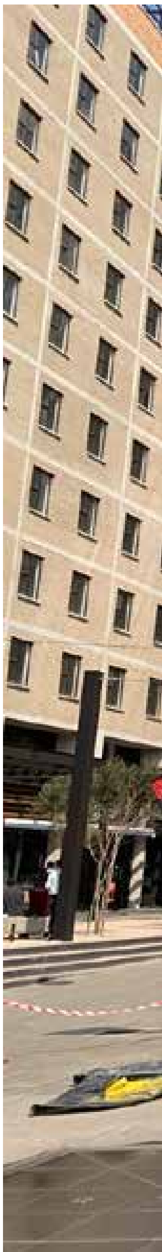
The structure is a reinforced concrete frame structure founded on CFA friction-piled foundations to account for poor soil conditions and high water tables. In some instances, double and triple pile groups were required to resist high column loads. From foundation level, there are two basement parking/retail levels where generally 400 x 750, 50 MPa RC columns resist the vertical loads. The columns allowing for a more open and flexible space on these levels.

On ground floor level, a transfer level was designed to transition the vertical loads to concrete bearing walls for the upper floors. This transfer level consisted typically of 900 x 1 100 transfer beams with 40 MPa concrete strength. The concrete bearing walls were a combination of 230-mm and 160-mm thick concrete walls, with two layers of reinforcement. 40 MPa concrete was specified for these walls up to third floor level, and 30 MPa up to roof level. This load bearing system advantageously allows for repeatability during construction and one-way spanning slabs, resulting in a very efficient slab design. The upper slabs were generally 200 mm thick, 25 MPa conventionally reinforced one-way spanning slabs, spanning typically 5.4 metres between concrete bearing walls. An added advantage of the concrete bearing walls is that there are no protruding columns into the residential unit spaces.

The building's lateral stability was provided by the two lift shafts (central to the building) and two stair shafts (on opposite ends of the building).

The mix design involved a mix of crusher sand, filler sand, different sized stone, cement, and ground granulated blast-furnace slag. Different concrete strengths were specified for different concrete elements ranging from 25 MPa to 50 MPa depending on the design requirement. Each mix had a water/cement ratio optimised for the required strength, generally with a lower water content to achieve higher concrete strengths.

This project was successfully executed because of the innovative design which has enabled the provision of extremely cost-effective concrete solutions for the precinct transformation.



JUDGES' CITATION

The Onyx is a new 13 storey apartment building in Johannesburg and stands as the flagship new building in Jewel City's redevelopment into a vibrant 'Live, Work, Play' precinct.

A concrete framed structure with concrete bearing walls makes up the main load bearing elements of the Onyx. Transfer beams enable vertical loads to be transferred at retail and parking levels to columns, allowing for a more open and flexible ground floor space. This load bearing system advantageously allows for repeatability during construction and one-way spanning slabs, resulting in a very efficient slab design. CFA friction piles provide the required support for poor soil conditions and ground water.

The aesthetic approach of the Onyx draws inspiration from the industrial presence of the surrounding context and celebrates the simplicity of warehouse architecture with an efficient and sophisticated solution. The building overlooks a new urban park with outdoor relaxation areas and multiple retail offerings

It is one of six city blocks, previously part of the fortress-like Jewel City that once housed Johannesburg's diamond dealers. It is an important addition to the city, opening up important pedestrian access along Fox Street, an area that was not previously easy to traverse safely on foot, while also bringing to market hundreds of new very cost-effective apartments aimed at those who live and work in the city.

This project is a deserved winner of the Fulton Award in the "Buildings greater than R50 million" category.

TEAM

Location: Johannesburg, Gauteng
Categories Entered: Buildings > R50 Million Value
Submitted By: EDS Engineering Design Services (Pty) Ltd
Client/Developer/Owner: Divercity Urban Property Fund/ Ithemba Property/Atterbury Property Fund
Project Manager/Principal Agent: GASS Architecture Studios
Structural Designer:EDS Engineering Design Services (Pty) Ltd
Architect: GASS Architecture Studios
Specialist Sub-Contractor: WBHO Construction (Pty) Ltd
Concrete Supplier: AfriSam South Africa (Pty) Ltd

Commendation

Newlands Cricket Ground Development

PROJECT DESCRIPTION:

The WPCA (Western Province Cricket Association) together with EDUDEV (Development Managers) and other stakeholders planned to develop the land around the Western Province Cricket stadium. The vision was to generate a long-term income stream to fund, amongst others, cricket youth development programmes in less fortunate communities, with the aim of uplifting communities through involvement in sport and coaching.

Construction commenced in February 2019, with lateral support and bulk earthworks to the 6-m deep 50 000 m^3 basement, followed by a complex multi-storey concrete structure.

The main concrete structure was completed by late 2020, with logistical constraints being the most notable challenge, as access to the construction areas was limited to a single lane entrance road. As a result, the majority of the 32 000 m^3 of concrete was pumped via a static line of up to 360-m long. Constructability was maximized with flat slabs and limited column sizes and the 7 no concrete shafts required focused attention, with a vertical accuracy of less than 25 mm tolerance being achieved on the 35 m high main lift shaft.

The use of a concrete in-situ structure enabled the team to adjust and adapt the design when needed, and thereby mitigating certain design and economical constraints.

An aesthetically pleasing result was achieved on the off-shutter concrete feature walls and certain other elements, and with Table Mountain as a backdrop to this spectacular development, concrete was the obvious choice for the primary construction material.

CONCRETE DESCRIPTION

For the lateral support around the basement perimeter, approximately 200 sheet piles were installed using CFA (continuous flight augured) piles, augured 18 metres deep into the ground. Off-site batched ready-mixed concrete grout was discharged and pumped into the piles, with reinforcing steel placed inside each of the piles. Approximately 700 piles of 600 mm diameter, were drilled and cast up to 15 metres deep into the ground to support the buildings vertically.

In situ-concrete columns were designed to be spaced on grids of 9,3 m x 8,5 m with 300 mm x 600 mm oval columns used to maximise the parking in the basements, as well as to enable a sensible slab footprint for the 280 mm flat slabs.

Lateral stability of the building was provided by means of seven reinforced concrete shafts for lifts and staircases. Flat slabs enable minimising the floor-to-floor distance to a statutory minimum in basements, as well as limiting the structural depth of upper levels to allow for the maximum number of building floors to be achieved within the overall building height restriction.

The Quadrant building is a six-storey building with concrete columns and flat slabs, for the exclusive use as an academic campus and regional head office for Varsity College. Floor plates are generally 270 mm to 280 mm flat slabs that are supported by reinforced concrete columns, walls, and shafts.

The five-storey Snake-Pit building, directly next to the Newlands Cricket pitch mimics the curvature of the building, and therefore the concrete slab edges follow the curved geometry of the cricket ground which also results in a radial column layout.

The lower double volume space of this building will house the Cricket Museum, which will display the inclusive cricket history of South Africa. Another special feature of this building is that one of the cricket pitch's six main light masts is located inside the perimeter of this building. Due to this mast having to remain, the building was planned to be built "around" the mast, effectively leaving a bay opening in the concrete slab on all floor levels, and once again illustrating the flexibility that concrete construction provides.

The north façade of the Snake-Pit Building is veiled with various aesthetically pleasing concrete "pop-out boxes", with exposed off-shutter concrete soffits.

The Wicket Building's main feature is the 18-metre span created by 1,2 m deep concrete down-stand beams, that give life to the enormous Multi-Purpose Hall, which will be used for a wide range of events and functions.

The three concrete water tanks in the basement of this building were constructed using a water retaining concrete mix, which when combined with watertight formwork systems and detailed planning, meant that no further linings or treatment were required.

JUDGES' CITATION:

The new development of 50 000 m^2 includes various parking levels, office spaces, educational block, a sports performance lab, a museum, conference centre, entrance block and a pedestrian bridge over the railway line. Various off-shutter concrete elements, designed to enhance the aesthetic and durability features of the development include:

- external public benches, stairs and walkways,
- stair 3, a 15-metre high element, positioned in the centre of the development,
- various façade pop-outs, portals, and plinths, and
- exposed aggregate polished concrete floors in numerous internal spaces.

The project's position within the existing precinct and the continued operation of the cricket stadium, meant that space on the site was extremely limited and logistics were very challenging. The 32 000 m^3 of concrete was batched off site and trucks entered the site through a small access road. The concrete was then either pumped, transported in small dumpers or craned to its final position, sometimes using three successive tower cranes. Most of the concrete was pumped with a static concrete

pump through pipelines up to 360 metre in length. On-site storage space for reinforcing was also limited, and an arrangement with the steel bending yard was made to cut, bend and deliver reinforcing within two to three days, which enabled just-in-time deliveries. In most cases steel was hoisted directly from the delivery truck onto the construction area and no "stock-steel" was kept on site.

The project achieved over 1,5 million injury free man hours, with over 400 workers on site daily during peak periods. This project has made significant sustainability achievements, especially in terms of water, energy and waste and is registered for a Green Star SA certification with the Green Building Council of South Africa.

The impressive way that the various challenges were met, and the final product achieved earns a commendation in the "Buildings greater than R50 million" category.

TEAM

Location: Cape Town, Western Cape
Categories Entered: Buildings > R50 Million Value
Submitted By: Stefanutti Stocks Western Cape
Client/Developer/Owner: Sanlam Life Insurance Limited & WPCA Property Holdings (Pty) Ltd
Development Manager: EDUDEV Africa (Pty) Ltd
Project Manager/Principal Agent: MDSA Project Management (Pty) Ltd
Structural Designer: Zutari (Pty) Ltd
Architect: Jakupa Architects and Urban Designers
Specialist Sub-Contractor: Viva Formwork & Scaffolding (Pty) Ltd
Concrete Supplier: Ciolli Readymix (Pty) Ltd

Commendation

Sol Tech Training College

PROJECT DESCRIPTION:

The Client required ± 13 000 m² for facilities that would accommodate a fully functional artisan training college consisting of:

- Training workshops for the various trades
- Ten classrooms for ± 40 – 50 students
- Office space
- Recreational space with eating facilities but also doubling as an interactive learning space
- Exam hall doubling as alternative group lecturing
- Ablutions that are spread out
- Outside recreation spaces i.e., protected courtyard, shaded spaces, and lawn area

Generally, the client required that the appearance interpreted a learning environment with a relevant aesthetic appearance referencing the context and local environment.

The design concept included "Third Vernacular Style" in particular the "Pretoria Regionalist Style". The design accommodates available building materials, the prevailing economy, as well as social and industrial circumstances.

The project was designed with specific reference artisans with building materials depicting skills, e.g., ornamental brick detailing, concrete moulding in concrete lintels and columns, brickwork in paving, and prefabricated concrete use e.g., windowsills, lintels, and canopies.

The Sol Tech Campus was designed and planned to promote an environment that stimulates learning while providing break away spaces that are calming and stress-free. It was the objective of the developer to give artisans a campus, not just a workshop, to be proud of. Emphasis was placed on the students experience by using environmental and behavioural psychology principles, stress reduction and attention restoration theory, social interaction, and integration with the community as well as employers.

CONCRETE DESCRIPTION:

The site consists of two areas, the first is a level area on a higher platform of the site for building activities and the remainder is a soft falling site to the east suitable for parking. The heights of the buildings are confined to a maximum of three levels on the most northern part of the site and two levels on the remaining portions due to the adjacent Air Force Base requirements. The ground conditions are dolomitic resulting in many stormwater and sewerage disposal requirements to be adhered to i.e., surface drainage and a two pipe HDPE dual containment underground piping system. The third site is located on the harsh highveld with dolomitic conditions and therefore the buildings are grouped together for protection of users against heat, cold and wind. The buildings are arranged around a central courtyard.

The courtyard and entrance axis are pedestrian-orientated with vehicle access on the perimeter. Buildings were confined to a specific area on site due to dolomitic ground conditions and the surface parking is placed on a suitable portion of property with falls away from campus buildings i.e., vehicles are less visible. Vehicles have access to the workshops from the rear and therefore are out of sight from the main campus spaces. The various building typologies are connected with a colonnade planned around the courtyard.

The courtyard and colonnade are designed as a link between useable space and pedestrian movement. This forms a unifying architectural element for the different building functions, e.g., classrooms, workshops, recreation, ablutions, admin, and services.

Much of the concrete architecture reflects a response to climate, landscape and local materials:

- Concrete structure exposed as finish with columns, lintels and copings is seen as the design discipline.
- Facebrick is used as a facing with aesthetic detailing.
- Plastered brickwork is used as an economic infill with a secondary role to concrete and facebrick.
- The colour combinations are firstly dictated by the in-situ grey concrete colour and is then contrasted with red brick and dark grey steel cladding.

The concrete mix consisted of a nominal 19mm quartzite stone, a fine aggregate of quartzite unwashed crusher sand, a Cem II 42.5R and Fly Ash.

JUDGES' CITATION:

The design concept follows the "Pretoria Regionalist Style", which developed after the Second World War to trigger large-scale development in the South African inland regions.

The following characteristics were used in the design:

- Use of in-situ concrete and prefabricated concrete panels as a structural and an aesthetic finish.
- Roof overhangs and shaded porches.
- Window openings that are protected from the sun with protruding, lintels, fins, and columns.
- Architectural language that respects climatic conditions such as north/south elevations, sun control and shading.
- Prefabricated concrete use in windowsills, lintels, and canopies.

The ground conditions are dolomitic resulting in the need to adhere to many stormwater and sewerage disposal requirements. The site is located on the harsh highveld and therefore, the buildings are grouped together for protection of users against heat, cold and wind.

To maintain a comfortable temperature range internally, the need for auxiliary heating and or cooling was reduced. Less than 35% of the buildings are mechanically ventilated, and all is complaint with SANS 10400. A Building Management System (BMS) controls power and HVAC usage to the campus, preventing any wastage or excess usage by the users.

Detailed design decisions were also made to reduce the buildings carbon footprint.

The impressive way that the required style was achieved together with the way the energy efficiency was achieved earns a commendation in the "Buildings greater than R50 million" category.

TEAM

Location: Pretoria, Gauteng
Categories Entered: Buildings > R50 Million Value
Submitted By: Jeremie Malan Architects & Interiors
Client/Developer/Owner: Kanton
Project Manager/Principal Agent: Pro Arnan Project Management
Structural Designer: DG Consulting Engineers
Architect: Jeremie Malan Architects & Interiors
Specialist Sub-Contractor: JC van der Linde & Venter Projects
Specialist Sub-Contractor: Structural Precast Elements CC
Concrete Supplier: Quantum Ready Mix Concrete

Winner

KleinJAN Restaurant

PROJECT DESCRIPTION:

This project called for the construction of an intimate, luxurious 20-seater restaurant focusing on dinners only and cooking classes, situated in The Tswalu Kalahari Reserve, a game reserve in the Northern Cape, South Africa. It is South Africa's largest private game reserve, covering an area of over 111,000 hectares on the edge of the Kalahari Desert.

The project brief was to embrace local products with a minimum of interference with the natural ecological cycles of the region. Extension and inclusion of the diminutive 100-year-old farmhouse, Boscia House, was required without changing any features.

Sustainability being a key consideration, research showed a submerged building would require less energy to keep cool in the heat of the day, or warm in the chilly desert nights. The decision to set the restaurant into the earth was not only for the utility of hiding the structure but also due to the known benefits of "thermal lag", found in pit architecture.

The concrete innovation is concealed in the earth. Although it is an intervention that cannot be objectified for its physical features above ground, the role concrete played was far more important. Thermal performance and comfort levels to sustain a full-fledged restaurant in the dead heat of the Kalahari Desert was the challenge.

The entire structure apart from the reservoir entrance had to be submerged into the earth. Concrete was used to structurally bind all spaces together, from the reservoir entrance to the wine and root cellars and finally, the main restaurant.

The design intent was always to have indoor and outdoor spaces to flow seamlessly into each other.

CONCRETE DESCRIPTION:

The restaurant was essentially built as a reinforced underground reservoir, i.e., not to contain water from the inside but the outside only. On the inside, only all the architectural features of a restaurant would be visible, and at no point will one see concrete...however, concrete was chosen for multiple reasons.

The structure had to withstand dead (sand) and live (large animals like buffalo herds) loads. The structure had to be watertight from the outside. Although it does not rain in the Kalahari that often, flood rains will occur from time to time, and therefore we had to consider that and design for buoyancy.

Construction began by removing the top layer of windblown sand onto an in-situ calcrete formation. Some of the calcrete bank had to be removed to make the structure fit in the excavation. The concrete structure itself could not provide sufficient mass for the buoyancy of the structure, and therefore soilcrete with rebar anchors were placed into the reinforced concrete structure below and behind certain retaining walls on the outside.

Thereafter, construction of the reinforced concrete basement floors, walls, columns, beams, and roof slabs commenced. Waterbars were placed across joints in the concrete as is normal for reservoirs.

Normal Portland grade 30/19 concrete was mixed by an on-site batch plant, reaching the required strength after the normal period of 28 days. Several specialised products and admixtures were used during the construction.

A reservoir is used as the portal or doorway, moving guests from Boscia House underground into the restaurant. "Petrichor", the name given to this reservoir, is the distinctive scent that accompanies the first rains. The circular water reservoir entrance to the restaurant houses a spiral staircase made of timber sleepers hanging from steel rods of the reinforced concrete roof, also designed as an underground reservoir. In the base, a water pool was formed in the reinforced concrete with a pump circulating the water to the roof, thus dripping in a circular form from the roof creating a special effect.

The long passage with barrel-vaulted roof and cellar leading from the "Petrichor" and dripping staircase to the restaurant was lined with bricks on the inside giving it a farm-like feeling. The service kitchen and cellar passage to the restaurant underground was lined with reinforced concrete retaining walls on both sides.

This project posed many challenges. One of our biggest challenges was to site the building underground in such a way it allowed us to open the restaurant façade to the view and cover the lid with earth that make it look like a low dune in the landscape in a relatively flat site. Another challenge was that the site is surrounded by an ancient Boscia or Shepherds trees, so the team had to carefully plan around the trees and make sure their roots were not disturbed during excavation.

This project where concrete was used to structurally bind all spaces together, leaves a lasting impression of the small, yet thoughtful details in service or design.

JUDGES' CITATION:

Patrons are welcomed into the diminutive 100-year-old farm home-stead, "Boscia House", yet the main restaurant is still totally invisible, as it is submerged into the earth, and only reveals itself when you enter the concealed door in the side of an old water reservoir.

In this project, the concrete innovation is concealed in the earth. Concrete was used to structurally bind all spaces together but also to cater for thermal performances, from the reservoir entrance to the wine and root cellars and finally the main restaurant.

The restaurant was essentially built as a reinforced underground reservoir not to contain water from the inside but the outside only. The structure, therefore, had to withstand dead loads from the sand and live large animals like buffalo herds as well as consideration of buoyancy during flooding.

The circular water reservoir en-trance to the restaurant with a spiral staircase was also designed as an underground reservoir. In the base, a water pool was formed in the reinforced base with a pump circulating the water to the roof, thus dripping in a circular form from the roof creating a "petrichor" effect. The service kitchen and cellar passage to the restaurant underground was lined with reinforced concrete retaining walls on both sides.

Klein Jan is the deserved winner of the 2022 Fulton Awards in the "Building less than R50 million" category, not for its objective visible concrete interventions but rather its concealed hidden pragmatic innovation situated in the vast open Kalahari Desert savannah. ✦

TEAM

Location: Tswalu, Northern Cape
Categories Entered: Buildings up to R50 Million Value
Submitted By: Kobus Duvenhage Bouers (Pty) Ltd
Client/Developer/Owner: Restaurant JAN
Project Manager/Principal Agent: Tswalu Kalahari Reserve
Structural Designer: MVD Kalahari Consulting Civil & Structural Engineers
Architect: Savile Row Tailored Environments
Concrete Supplier: Olivier Construction (Concrete Division)

Winner

Old Cape Quarter

PROJECT DESCRIPTION:

The innovative use of concrete at the Old Cape Quarter development in Cape Town has been fundamental to this project's success, particularly in the preparation of columns, bases, and piles to support the new four-storey residential structure. Indeed, the development, supply and application of the appropriate concrete mixes in a complex and challenging contract has shown the value of close collaboration between the project team. By working together to address this challenging project – both planned and unexpected – the project team demonstrated excellence in the use of concrete.

Located in the fashionable De Waterkant district adjacent to Cape Town's central business district, the Old Cape Quarter was refurbished and expanded. Transforming from a popular retail destination, it is a high-end mixed-use hub with 55 luxury apartments augmenting the retail and office space.

As a construction project, the upgrade has dealt with complexities related to heritage and environmental considerations, as well as its location in a busy suburb with narrow streets. This project demonstrated ingenuity in the way it has used concrete to strengthen foundations and columns within an existing structure – and this, under unusually demanding conditions.

Underpinning the new four-storey apartment building was a key focus of the early phases, requiring innovative strategies from the whole project team. Variable ground conditions discovered after project initiation demanded that several piles had to be executed through the existing base. Several columns and bases had to be demolished and reconstructed, with props required where bases and columns were removed. Others had to be strengthened by adding extra concrete around them.

Proximity to the city centre, water channels and the harbour highlighted the environmental sensitivity of the area.

CONCRETE DESCRIPTION:

Underpinning the new structures required an innovative approach. Due to variable ground conditions, a number of piles had to be executed through the existing base. This required the core-drilling of 300 mm diameter holes through the base, for transferring the load onto the piling.

This project had to be executed within the existing bases and columns in the structure resulting in some columns and bases being demolished and reconstructed, with props required where bases and columns were removed. Others had to be strengthened.

Among the challenges was a lack of space in the basement for the use of normal class 3 formwork. Instead, extensive use was made of biscuit columns, where reinforcing around the column was added, and core-drilled at an angle from above – adding grout to build up the column sizes. The 60 MPa grout required could only be poured manually by wheelbarrow, which meant that it was not fast enough to use up a full concrete load from the readymix truck before it began to harden. To overcome this, just one cubic metre of readymix was delivered at a time to the site. Lack of space for skips and bags, posed challenges for the disposal of concrete on site, leading to the use of slush packets to collect sludge mix when the concrete pump was being lubricated.

The gaps in the column reinforcing were smaller, so an aggregate size of 9 mm was critical.

The concrete supplier is a leader in the development and application of composite cements and used ground granulated blast-furnace slag (GGBS) as sustainable cementitious raw materials in the concrete for this project. The sudden closure of the nearby source of GGBS, was overcome by sourcing pulverised fly ash (PFA) and incorporating this alternative ingredient while still meeting project specifications.

By the time all the necessary biscuit columns had been poured, 153 m^3 of this 60 MPa mix was supplied to site – meaning that 153 truck cycles had been completed with just one cubic metre conveyed in each.

Ten different mixes were employed during the project to suit various applications. Amongst these was a special pumpable 35 MPa mix with a 6,7 mm stone, applied specifically for where the apartments were being built, and where post-tensioned concrete could not be used. Limited use was made of a 70 MPa mix with silica fume during the early days of excavation of the basement, where existing columns had to be built up.

For the penthouse swimming pools on the fifth level of the building, a 40 MPa waterproof concrete was used. Post-tensioned slabs utilised a 30 MPa with 15 to 20% fly ash, which guaranteed 18 MPa in three days. A 15 MPa concrete was supplied for foundations.

The challenges on this project were all overcome in line with the Old Cape Quarter's intention to qualify for the level 4 in terms of green build standards, resulting in extensive recycling. Water harvesting was conducted from existing roofs and extensive use was made of old ceiling boards as void fillers for planters.

JUDGES' CITATION:

The redevelopment of the Old Cape Quarter includes the partial demolition of the existing building to strengthen its structure, and the addition of a modern four-storey residential component of brickwork.

TEAM

Location: Cape Town, Western Cape
Categories Entered: Buildings > R50 Million Value | Innovation & Invention in Concrete
Submitted By: AfriSam South Africa (Pty) Ltd
Client/Developer/Owner: The Cape Quarter Property Company (Tower)
Principal Contractor: GVK-Siya Zama Building Contractors (Pty) Ltd
Project Manager/Principal Agent: Igual Project Managers (Pty) Ltd
Structural Designer: Sutherland Engineers (Pty) Ltd
Architect: DHK Architects
Quantity Surveyors: Smith & Co (Pty) Ltd
Specialist Sub-Contractor: VSL Construction Solutions (Pty) Ltd
Specialist Sub-Contractor: Franki Afrika (Pty) Ltd
Specialist Sub-Contractor: Siyazama Steel (Pty) Ltd
Concrete Supplier: AfriSam South Africa (Pty) Ltd

A significant aspect of the innovation on the project arose from having to work within the existing bases and columns in the structure – many of which were no longer fit for purpose. Some had to be demolished and reconstructed, with props required where they were removed.

The lack of space in the basement for the use of normal class 3 formwork led to the extensive use of biscuit columns, where reinforcing around the existing column was added using grout to build up the column sizes.

The concrete for the biscuit columns had to be poured through 60mm core holes from the slab above. This could only be done manually by wheelbarrow, severely restricting the operation's capacity to relieve the readymix trucks of their usual six to eight cubic metre load. Subsequently 153 m^3 of concrete was delivered in 1 m^3 batches in readymix trucks. This added to traffic congestion in the narrow streets.

The innovative solutions involved considerably more work and materials. The initial bill of quantities specified about 4 000 dowels, while the final requirement was closer to 12 000 dowels. The project also used most of the epoxy in the Cape Town market and demanded many more props than anticipated.

Three existing heritage buildings around the site had to be accommodated which meant preserving and protecting the outer heritage walls of the existing structure, which date back about a hundred years. A number of existing structures were not allowed to impacted, while others were made more structurally sound.

The innovative ways that all these significant challenges were met has made this project a winner in the category "Innovation and Invention".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Commendation

New Ashton Arch

PROJECT DESCRIPTION:

The client's brief involved improvement, to acceptable modern standards, of the flood resilience and overall safety of the road. Technical proposals were required to address the risk of frequent, and severe, flooding at the Cogmanskloof River Bridge in Ashton with due cognizance of the restrictive boundary conditions, most notably the large skew angle, high debris load as well as adjacent properties in the urban setting.

The design which was finally adopted consisted of a single span (110 m) concrete tied-arch solution with a deck suspended by stay cables which accommodates four traffic lanes and two walkways. This largely eliminated the possibility of debris build up and also provided the shallowest deck depth option (key considerations). Prestressed concrete was the material of choice since the primary load transfer mechanism of the tied-arch bridge is compression in the ribs and tension in the tie-beam.

CONCRETE DESCRIPTION:

Crushed concrete from the demolition phase was incorporated within the engineered-fill layers and in the grouted rock fill layers.

A specially developed, high mobility 50/13 pumpable concrete mix was designed for casting the tie points. High-frequency compressed-air driven internal poker vibrators were used to consolidate the concrete. The pump tubes were gradually withdrawn as the concrete filled the element, and top shutters fitted incrementally for the elevated parts of the element. The remainder of the massive element was completed with the site-approved 50/20 concrete mix and placed mostly by pump and consolidated by regular internal poker vibrators.

The peak temperature within these massive elements were monitored via embedded sensors placed at the centre and outer edges of the massive pours.

The 50 MPa high-strength concrete utilized for the main arch components; as well as sensitivity of the arch structural form to elastic stiffness, drying shrinkage and creep actions; and the design service life of 100 years, required that the mix design be subjected to a specialized laboratory testing regime.

The incorporation of fly ash in the binder system assisted with the durability properties, improved workability, and concrete finish, improved thermal performance, improved resistance to hot weather concreting, and improved the sustainability aspects of the project. The fly ash addition significantly reduced the effective carbon emissions and resulted in a lower embodied energy for the concrete.

Particular attention was required to conduct comprehensive cover to concrete testing on all the elements.

The four spring points are massive elements, requiring management of thermal performance of the concrete and associated cumulative strains. In these congested zones the critical mission was to ensure no cast cavities were formed. The deck of a concrete tied-arch bridge is prestressed to counter the thrust action of the arch ribs. This is achieved by placing concentric tendons in the tie-beams.

During tensioning of the first two tendons, significant under-extensions of up to 30% was recorded. The activity was halted, and careful investigation revealed that the method of installation had resulted in the entanglement of the individual strands. The faulty fully stressed tendons were destressed, discarded, and replaced with new strand. Strands that were installed in the remaining ducts were removed and re-installed by pull through method. Extensions measured after successful re-installation of strands were within 6% of the theoretical elongations, and were accepted.

The superstructure was completed adjacent to the existing road-alignment and was launched transversely into its final position onto the adjacent substructure; a first of this kind of construction in Africa.

JUDGES' CITATION:

The newly completed Ashton Arch is South Africa's first concrete tied-arch bridge constructed using a transverse launching method. The bridge replaces an existing multi-arch bridge, built in the 1930's, which did not fulfil its functional requirements, including service life, width and hydraulic capacity, anymore.

The design which was finally adopted consisted of a single 110 m span concrete tied arch with a deck suspended by stay cables which accommodates four traffic lanes and two walkways. This largely eliminated the possibility of debris build up and provided the shallowest deck depth option.

Construction adjacent to the existing bridge and transverse launching after completion minimized traffic disruption during construction.

Extensive modelling and monitoring were carried out before and during construction and included various concrete mix designs. Further structural monitoring was done in collaboration with the University of Cape Town's COMSIRU and included strain measuring at vulnerable zones and hanger force measurement.

The use of a transverse launching method for construction of a concrete tied-arch road bridge is a first in South Africa when more than 8000 tons of concrete and steel was moved over 24m in less than 24 hours after several years of meticulous planning, design and construction.

A first and innovative application of this bridge engineering technique for a concrete tied arch bridge in South Africa ensures that this project deserves a commendation in the category "Innovation and Invention in Concrete". ✦

TEAM

Location: Ashton, Western Cape
Categories Entered: Infrastructure > R100 Million Value | Innovation & Invention in Concrete
Submitted By: AECOM SA (Pty) Ltd
Client/Developer/Owner: Western Cape **Government:** Department of Transport and Public Works, Roads Branch
Project Manager/Principal Agent: AECOM SA (Pty) Ltd
Structural Designer: AECOM SA (Pty) Ltd
Main Contractor: Haw & Inglis Civil Engineering (Pty) Ltd
Specialist Sub-Contractors: Amsteele Systems (Pty) Ltd; Allweld Marine & Industrial (Pty) Ltd; Maffeis Engineering (Pty) Ltd; Nyeleti Consulting (Pty) Ltd
Formwork Supplier: Form-Scaff (Pty) Ltd
Concrete Supplier: Afrimat Ready-mix Cape (Pty) Ltd

Commendation

Essex Terrace / M13 Bridge Modification

PROJECT DESCRIPTION:

The existing Essex Terrace underpass was built in 1971. Significant urban development in the neighbourhood urgently requiring additional lane capacity through the surrounding interchange. Rather than building a new bridge, it was decided to add an additional simply-supported deck span. The existing bridge abutments comprised large reinforced concrete walls, which allow for significant structural modification. The wingwalls and counterforts were removed, and the resulting concrete element could be carefully transformed into an unexpectedly elegant pier by the specialist concrete contractor.

It was critical to minimise lane closures on the overlying M13 highway, so a hybrid top-down, build-and-dig-out deck construction methodology was used. Preparation for deck construction was minimised by initially only constructing the vertical load-carrying components of the abutment and using ultra-lightweight piles that carried no horizontal or bending load. Once the deck was complete and carrying traffic, further excavation could continue below, and a soil nail lateral support system was installed. The sprayed concrete of the soil nail system was troweled smooth to mimic an off-shutter concrete finish. The resulting highly optimised abutment massively reduced the amount of material in construction and excavation.

An experimental approach was also to remove the bridge joints and replace them with fibreglass reinforcing grids in the asphalt layers.

The project deliberately did not match the new deck section to all aspects of the existing deck section. The existing deck is a shallow multi-cell box girder, while the new deck is a lightweight triple T-beam design. The result is a concrete structure that lets its complex history be seen.

This project used several experimental solutions to address aesthetic and sustainability concerns.

CONCRETE DESCRIPTION:

The sprayed concrete in the soil nailing system was shaped directly by hand to give a 'trowel-finish'. The layers of light mesh in the sprayed concrete are assumed to make it less rigid than a conventional concrete wall, allowing it some capacity to flex and accommodate thermal movements, thus limiting cracking.

It was decided to experiment with removing the expansion joint nosings on both the new and old decks. The tops of the expansion joints were simply sealed off, and fibreglass reinforcing grids installed between the overlying asphalt layers to distribute the strains of deck expansion and contraction. Ongoing monitoring of the performance at the different joints will be necessary, and there may still be a need for remedial work in the future. Removing the joints provides a pleasantly smooth riding surface.

The two spans of this bridge have unmistakably different deck cross-sections. The old deck mostly has a single uniform soffit, while the new deck is comprised of T-beams with multiple soffit surfaces. This contrast is moderated by the sections having the same depth, and the outer cantilevers having the same width, creating continuity.

The 'top-down' construction sequence was as follows: first, those components of the new abutment designed to carry vertical load, together with the conversion of the old abutment to a pier, then the deck, then the lower portions of the new abutment designed to carry lateral loads.

The new West abutment was a combined bearing seat and pilecap. Complex geometry of the overlying road, with its steep crossfall, combined with the awkward shape of the upstands underneath the deck cantilevers made the setting out difficult.

For the conversion of the existing West abutment to a pier, the contractor excavated locally and installed concrete columns which were doweled into the existing abutment base and walls. The design of these columns was kept simple to minimise construction time. A lower strength concrete mix was used here to match the concrete in the old abutment and reduce shrinkage effects. Specifications for connecting new concrete to old were carefully adhered to, particularly ensuring the existing wall was water damped for 24 hours.

The straightforward reinforcing steel for the deck allowed less experienced steel-fixing subcontractors to be used, broadening opportunities for job creation and supporting local businesses.

To allow access for poker vibrators in the highly rebar congested diaphragms, some of the lacing bars in the top mat were only placed after the beams had been filled up with concrete.

Lateral support was provided with grouted anchors and a single layer of mesh and sprayed concrete. The lateral support is flexible to a point and was also allowed to settle slightly by doing a larger area of finishing coat than the initial area.

A variety of concrete mixes were used for the different elements to accommodate grouting, low shrinkage, pumpability and sprayed concrete requirements.

JUDGES' CITATION:

This project used several experimental solutions to support a design rationale that directly addressed sustainability concerns. It also involved some boldly progressive and effective responses to the aesthetic challenges associated with modification of an existing structure.

The new bridge span was built using a hybrid top-down, build-and-dig-out methodology, as an experimental project aimed to investigate the viability of this construction method in the future.

The new abutment is extremely minimalist, being comprised of lightweight piles and soil nails rather than the conventional heavily reinforced concrete abutments which have much higher financial, time and sustainability costs.

The primary reason for the top-down approach was to minimise the time-consuming installation and subsequent demolition of expensive and wasteful temporary lateral support between the two carriageways, while the first deck was being constructed. This temporary lateral support was necessary because the two carriageways' decks needed to be built separately, one at a time, so one of them could always remain open to reduce traffic disruption.

This project demonstrates the versatility of concrete for use in radically different construction systems. The result is a structure that lets its complex history be seen, but without being ill-fitting and ugly. It becomes a bridge with a story, and an organic life of its own. This also ties in with the agile look created by the raked bullnoses.

The successful experimental solutions applied on this project earn it a commendation in the "Innovation and Invention in Concrete" category.

TEAM

Location: Durban, KwaZulu-Natal
Categories Entered: Infrastructure up to R100 Million Value | Innovation and Invention in Concrete
Submitted By: EMPA Structures / eThekwini Municipality, Roads Provision Department, Structures Branch
Client/Developer/Owner: eThekwini Municipality – eThekwini Transport Authority (ETA)
Project Manager/Principal Agent: eThekwini Municipality, Roads Provision Department
Structural Designer: eThekwini Municipality, Roads Provision Department, Structures Branch
Specialist Sub-Contractor: EMPA Structures (Pty) Ltd
Concrete Supplier: Lafarge South Africa (Pty) Ltd

Entry

Aeroton – 1.4 Mℓ Water Tower

PROJECT DESCRIPTION:

The construction of a water tower in Aeroton, an industrial area south of Johannesburg, stands out as a sound example of excellence in the design and construction of concrete structures.

The new 1,4 Mℓ water tower was constructed to address the previous irregular water supply constraints to sub-districts located within the Aeroton reservoir zone. It provides adequate capacity to supply at least six hours of storage of the annual average daily demand of the supply zone and improves dynamic pressures in the high lying areas. This has reduced direct feeds into the reticulation network from the Rand Water Bulk Supply.

The main or global structure consists of the foundation, tower, and tank, including the floor, walls, and roof. Secondary elements included the steel staircase, the concrete landings (cantilever slabs), access manhole and supporting roof structure (columns and beams).

It was built in record time by M&D Construction Group and the company's enterprise development joint venture (JV) partner, Motla Projects. Their state-of-the-art construction methods, including inventive scaffolding and formwork solutions. provided an impressive 30% saving in construction time. The JV achieved practical completion well ahead of the scheduled deadline in November 2019 and the entire project was concluded within budget.

CONCRETE DESCRIPTION:

The stability of the reservoirs is achieved by the structure acting as a cantilever, with wind representing a destabilising load and the weight of the structure the stabilising load, which is the most conservative when the tank is empty.

Unique building methodologies, innovative scaffolding and formwork solutions enabled the joint venture to achieve an impressive 30% saving in construction time on this contract. Novel internal and external climbing platforms with circular plywood panels accelerated the construction of the core of the shaft in an extremely confined area. These also enabled the contracting teams to access the base of the shaft of the tower to commence working on the ancillary works well ahead of schedule after the first lift had been completed.

The same platforms were used to assist with the installation of the main working stages for the cone after six 3,85 m pours were completed. Installed at ground level, they were also easily installed by the contractor using a crane.

A novel way, based on Peri's SB Brace Frame system, was employed to safely construct the tower's conical-shaped tank 23 m above ground level. The large platform also simplified and facilitated quick assembly of the shuttering for the in-situ cone.

A unique system comprising radiused tubes and tension rings was designed specifically for this aspect of the works programme to contain the lateral loads of the inclined walls.

This secure "self-balancing" system holds the concrete without the need for propping. Believed to be the first of its kind to be deployed on a circular structure in South Africa, it comprises many custom designed and manufactured components that are now part of the scaffolding and formwork supplier's stock for future projects.

The work scope also included the construction of a R10,1-million pump station and interconnecting piping. The main structure consists of the 268 m² foundations, which have a pressure of about 150 kPA consists of the tower and tank, including the floor, walls, and roof. Secondary elements include the steel staircase, cantilevered concrete slab landings, access manhole, and roof structure, including the columns and beams.

The JV used an impressive 2600 m² of formwork, 90 t of reinforcement and 895 m³ of concrete. This is in addition to the 600 m³ of excavations it undertook for this project. ✦

TEAM

Location: Aeroton, Gauteng
Categories Entered: Infrastructure up to R100 Million Value | Innovation & Invention in Concrete
Submitted By: Murray & Dickson Construction (Pty) Ltd
Client/Developer/Owner: Johannesburg Water (SOC)
Project Manager/Principal Agent: Afri-Infra Group
Structural Designer: Afri-Infra Group
Specialist Sub-Contractor: Peri – South Africa
Concrete Supplier: AfriSam South Africa (Pty) Ltd

Entry

Cornubia Boulevard Bridge Project

PROJECT DESCRIPTION:

The Cornubia Boulevard Bridge links the Umhlanga Ridge and Cornubia Development town centres on either side of the N2 by means of the Cornubia Boulevard.

This bridge deck is a three-span continuous prestressed concrete box girder. The bridge is 125 m long. The deck is curved in plan and has a varying width which carries 8 lanes of general and Integrated Rapid Public Transport Network (IRPTN) traffic. The sub-structure is founded on augered piles. This bridge design had a couple of design challenges that had to be resolved. These included the foundation design, which was complicated due to the very high sub-structures of approximately 15 meters. The other challenge was the varying width of the box girder deck which was solved by varying the bottom width of the deck and by designing appropriate construction and pre-stressing sequences.

An interesting construction element proposed by the contractor was the use of polystyrene as a permanent void former to the box decks as opposed to the conventional temporary timber shutters.

The road design dictated the vertical geometry, which resulted in very high and long abutments with large exposed concrete faces. It was decided to curve these walls to soften their appearance.

CONCRETE DESCRIPTION:

Choosing concrete for the bridge deck proved beneficial to both the design team and client.

Reinforced concrete was used for the sub-structure, and post-tensioned concrete for the super structure. The superior compression capacity of concrete was harnessed in the structural design of both applications. Concrete provided the client with a durable and sustainable structure that has low maintenance requirements in the future.

The use of in-situ concrete as the primary construction material was critical in ensuring that the project team could make the best use of local labour on the bridge. Concrete also provided the design team with the opportunity to introduce small architectural enhancements, which helped soften the look of a relatively large structure.

The use of polystyrene as a permanent void former to the box decks rather than the traditional temporary timber shutters saved one month of construction time.

The deck comprises three prestressed concrete single cell box girders, cast in three stages, longitudinally and transversely. The deck depth is 2.1 m, and the width varies from 34 m to 43 m. The outside cantilevers were kept at a constant width of 3.15 m and the slabs between the decks were kept constant at 5.5 m. The bottom of the box varied from 5.11 m to 7.635 m.

The substantial volumes of concrete contained in the 9m diameter piling, the counter-forted abutments, and the triple stitched deck were placed without a hitch, and to a very creditable standard.

One of the more complicated portions of the design was the box girder deck. The deck width varied from 34 m on the one end to 43 m on the other. The conventional way to accommodate a varying deck width for a box deck is to vary the cantilevers. However, this was not possible with this bridge as the amount by which the deck varied was excessive. As a result, it was decided to go the unconventional route of varying the bottom width of the box deck. Concrete, as a cast-in-situ material lends itself well to this type of application. Furthermore, the post-tensioning design was created with the varying width of the deck in mind.

To enhance the sustainability and durability of the structure, special attention was given to the layout of the reinforcing and durability concrete was specified. All concrete members were sized and optimised to limit the amount of material used and to provide a sustainable and economic design. ✦

TEAM

Location: Durban, KwaZulu-Natal
Categories Entered: Infrastructure > R100 Million Value
Submitted By: Royal HaskoningDHV
Client/Developer/Owner: eThekwini Municipality
Project Manager/Principal Agent: Royal HaskoningDHV
Structural Designer: Royal HaskoningDHV
Specialist Sub-Contractor: CMC di Ravenna SA Branch
Specialist Sub-Contractor: Vumani Civils
Specialist Sub-Contractor: Roadspan Group (Pty) Ltd
Concrete Supplier: AfriSam South Africa (Pty) Ltd

Entry

Driefontein Emergency Overflow Dam

PROJECT DESCRIPTION:

The Emergency Overflow Dam at Johannesburg Water SOC Ltd (JW)'s Driefontein Wastewater Treatment Works (WwTW) was initially an unlined earth pond used to temporarily contain any excess incoming sewage flow during peak storm events. The capacity of the dam dropped significantly over the years due to loss in the airspace through solids deposition in the dam.

In the wake of new environmental management legislation, the dam was also in need of upgrades in order to be compliant. In naming only two aspects needing upgrades, a lining system had to be introduced to the dam to prevent subsurface contamination and the capacity limitations had to be resolved in order to comply with stipulated permissible spills.

Driefontein is a live plant, therefore, the proposed approach was to construct a concrete lined dam with dual compartments. This allowed for the dam to remain operational during construction and also facilitated the maintenance and cleaning of the dam without losing its operational capacity.

The upgrade works to the Emergency Overflow Dam, increased the capacity of the dam from 5.7 Mℓ to 22 Mℓ.

CONCRETE DESCRIPTION:

Segmentation of the dam was achieved by constructing a 500-mm wide centralised reinforced concrete partition wall which also houses reinforced concrete twin water draw off structures. The twin draw-off structures serve dual functions of overflow structures and main abstraction structures. A reinforced concrete wall was selected to partition the dam into two compartments over a secant pile wall which was proposed initially because of its cost-effectiveness, easiness to construct, high impermeability and appealing aesthetics.

The main abstraction is at the floor level of the dam which feeds into large diameter steel pipelines that convey flow to pumps housed in a composite reinforced concrete and brick pump station. The overflow arrangement on the draw-off structure is achieved through weirs positioned approximately 1m below the crest of the dam. Added features to the division wall and draw-off structure include vehicular access for collection of screened debris at the inlet of the abstraction lines.

The dam is fed by a reinforced concrete splitter box which hydraulically splits incoming sewage flow equally into each compartment. The flow to each compartment is recorded by using area-velocity flow meters located at the discharge point into the dam.

The surface of the dam has been lined with a 150 mm fibre-reinforced concrete slab cast on top of the dam's triple geo-membrane liner system to provide a durable surface for vehicular access for desludging and maintenance purposes. The dam's triple geo-membrane liner system prevents sewage from seeping into the subsurface ground. The liner also consists of a subsoil drain and leakage detection system which drains groundwater away from the dam.

The basin and embankments of the dam are lined with a polypropylene fibre reinforced 25 MPa concrete that is designed to serve its main purpose for crack control and also to provide a workable consistency for application on the slopes of the embankments.

The 150mm-thick fibre reinforced concrete floor has been cast on top of the lining system on the basin and embankments of the dam. The concrete floor enables vehicular access to the floor level for maintenance or cleaning purposes. A skid steer loader can easily access the dam to scrape off and load solids that accumulate on the floor of the dam. This facility ensures that there is no loss of capacity in the dam due to the accumulation of sediment.

Twin reinforced concrete draw-off structures were constructed at the opposite side of the inlet pipes, where the sewage is extracted from the floor of the dam on either side of the partition wall (each compartment). A sluice gate has been installed at the draw-off structure to enable isolation of suction pipelines. If maintenance is required on a suction pipeline the sluice gate can be closed off at the draw-off structure.

TEAM

Location: Muldersdrift, Gauteng
Categories Entered: Infrastructure > R100 Million Value | Innovation & Invention in Concrete
Submitted By: Zitholele Consulting (Pty) Ltd
Client/Developer/Owner: Johannesburg Water (SOC)
Project Manager/Principal Agent: Zitholele Consulting (Pty) Ltd
Structural Designer: Zitholele Consulting (Pty) Ltd
Concrete Supplier: Scribante Concrete (Pty) Ltd

Entry

Emoyeni Reservoir

PROJECT DESCRIPTION:

The design and construction of the Emoyeni Reservoir was unique in that several aspects in both areas deviated from previous designs as well as construction techniques. For a water retaining structure of this size, the only option is reinforced concrete. Circular reservoirs are more cost effective however, in this case the available land did not allow for a circular shape and a rectangular shaped structure was the only option.

For this design, a different approach, doing away with the movement joints in the structure, was employed. As this was a very large concrete structure (100 m x 35 m x 8 m), the removal of movement joints required careful modelling. Furthermore, the previously utilised tapered wall width was changed to a uniform wall thickness. The modelling of the structure showed that the uniform thickness walls performed better as a propped cantilever with smaller crack width as well as making the reinforcing designs at the corners simpler and easier to construct. Construction joints were still required, however the specification on these was given careful consideration and was closely monitored during construction. Although the steel quantity increased in order to mitigate cracking, this cost was offset against the savings in water bars as well as the decrease in construction duration and the lower risk of leakage.

These design changes resulted in a structure that was commissioned with zero leaks and a high quality of concrete. The construction presented several challenges. The large structure was constructed in the heart of a high-income residential suburb with very little working space and with issues such as noise pollution, dust pollution and traffic congestion to take cognisance of. The existing water storage system that was on the site needed to be operational throughout the contract duration.

CONCRETE DESCRIPTION

The design called for no movement joints in the walls of the concrete reservoir. In order to mitigate the shrinkage cracking resulting from the lack of movement joints, additional reinforcing was required. The additional cost of steel was a concern to the client however this was offset against a savings in water bars, a shorter construction duration as well as a decreased risk of leaking.

Another change to previous designs was to use a uniform wall thickness as opposed to tapered walls. This resulted in the wall mid-height crack width reducing from 0.17 mm to 0.15 mm for the uniform wall. Another benefit to using uniform walls was the less complex reinforcing detailing at the corners.

The roof slab is 250 mm thick with a sloping soffit and is covered with a 100 mm thick, 40 mm uniform stone.

All concrete was designed to a tightness class 1. Some surface staining and damp patches was acceptable, and the crack width limit was 0.2 mm. However, for wall elements in direct tension, a design crack width limit of 0.15 mm was utilised.

Another innovative feature during construction was proposed by the contractor which was to pour the 8m high walls in a single lift. The concern with this technique is that a) the fines and aggregate would segregate in such a high drop and b) achieving the correct vibration at the lower levels would be difficult. To mitigate these problems, the contractor was instructed to use a pumped concrete mix in combination with tremie pipes to avoid separation and to use shutter vibration at the lower levels in conjunction with needle poker vibrators to achieve adequate compaction of the concrete.

The overall size of the reservoir is 98 m long by 34 m wide by 8.2 m high. Four metres of the reservoir is below ground level and 4 metres are above ground level. The walls of the structure are 450 mm thick, and the floors taper from the wall at 500 mm thick down to the floor panels at 200 mm thick. Circular concrete columns are 450 mm in diameter and are spaced at 5.5 m. The column bases are 1200 mm square and 250 mm in height while the column head is tapered to 1200 mm to the soffit. The roof slab is 250 mm thick covered in a 100 mm thick layer of 40 mm stone.

Concrete was used for strength and water tightness, but the structure was clad in a brick skin to address the aesthetic concerns in this high-income community, who preferred the look of brickwork over the more industrial concrete look.

TEAM

Location: Durban, KwaZulu-Natal
Categories Entered: Infrastructure up to R100 Million Value
Submitted By: Knight Piésold (Pty) Ltd
Client/Developer/Owner: eThekwini Water and Sanitation
Project Manager/Principal Agent: Knight Piésold (Pty) Ltd
Main Contractor: Afrostructures (Pty) Ltd
Structural Designer: Knight Piésold (Pty) Ltd
Safety Consultant: Safety Connection Consulting (Pty) Ltd
Concrete Supplier: Métier Mixed Concrete (Pty) Ltd

eZimbokodweni Pipe and Pedestrian Bridge

PROJECT DESCRIPTION:

The construction of the eZimbokodweni sewer pipe and pedestrian river bridge in Umlazi, south of Durban, was necessitated as the existing reinforced concrete encased sewer syphon and trunk line which continuously required maintenance and unblocking, also provided the only point for pedestrians to cross the Mbokodweni River. This low-level pedestrian crossing was impassable during flood conditions, and along with the existing sewer syphon, both required upgrading as these were progressively being undermined due to illegal sand quarrying.

The most distinctive element of the pedestrian pipe bridge is the ground-breaking photoluminescent precast polymer concrete parapets.

Until recently it has not been possible to create photoluminescent effects in concrete. This is chiefly due to concrete's opaque nature, as well as the way it hydraulically bonds during the cementitious process.

The absorption and emission of light is only possible in materials that allow light to pass through it, ruling out standard concrete. Through research and development, phosphorescent particles have now been successfully chemically infused into polymer concretes which release the energy stored during the daylight hours as light at night, improving night-time pedestrian and cyclist safety, without any reliance on electricity.

To add a further dimension the cast in-situ concrete footpaths, approaching the bridge, feature exposed photoluminescent aggregate, clearly lighting the footpath for pedestrians and cyclists to safely follow in the dark.

This project demonstrates that creativity does not always come at a prohibitive cost or compromise on safety. It showcases how technology can improve the quality of life, allowing communities to re-imagine their future.

CONCRETE DESCRIPTION:

This project comprises the construction of a 160-m long pedestrian bridge which incorporates a 1000 mm diameter HDPE sewer line in the reinforced concrete deck.

The bridge deck was formed using six precast prestressed concrete beams (each 26.3 m in length) which was necessary to support the loading of the integral sewer line. The superstructure is supported on five cast in-situ reinforced concrete piers and two abutments and standing approximately 10 m above the existing river. The bridge substructure was founded on 26 cast in-situ reinforced concrete piles. The pre-stressed concrete beams used in the deck, allowed for the construction of the long spans of approximately 26 m. These beams were pre-stressed off site and were transported from Johannesburg to Durban, requiring special transport licenses for abnormal loading.

During the construction phase of the project, it was identified by the community that lighting was needed on the bridge for safety reasons. Given the high cost of electrical lighting, load shedding and theft of electrical cables, an innovative solution to illuminate the bridge, was found in using polymer concrete, infused with photo-luminescent particles which creates a glow in the dark effect.

The revolutionary adoption of photo-luminescent polymer concrete in the handrails and posts, added a new dimension to the project as it will for infrastructure projects going forward.

The environment where the structure is located can be described as aggressive with a high humidity. It was therefore anticipated that the structure would be exposed to carbonation induced corrosion and to low levels of chloride attack. This structure had to therefore be treated as subject to a severe environment for the purposes of limiting crack widths, adequate cover to reinforcement and concrete durability.

The bottom half of the HDPE sewer pipe is encased in concrete to restrain excessive movements of the pipe due to thermal expansion and contraction. To prevent the pipe from floating during the casting of the encasement concrete the pipe had to be tied down. The holding down points were spaced at 3m from each other to prevent excessive local stresses developing at these positions.

It was contemplated that the inside of the bridge could be flooded in case of a spill. The holding down mechanism will therefore provide for flotation of the pipe for its design life. Normally metallic holding down straps would be used for this purpose. In this case it was considered prudent to use cast in-situ reinforced concrete collars. This would also eliminate the risk of damage to the precast deck units by attaching bolted metal straps. Filling the pipe before casting the encasement concrete negated the upward flotation forces completely.

Entry

For various safety and environmental concerns, it was decided not to provide any manholes for access into the pipe on the bridge deck

The use of the pre-stressed concrete beams was beneficial to construct a crack-free structural member and tackle shrinkage and temperature effects. As a result, the ingression of detrimental agents is prevented which helps in avoiding reinforcement corrosion.

The bridge was made continuous over the piers, eliminating the need for expansion joints at the piers. The expected longitudinal movements due to temperature fluctuations, shrinkage and creep of the bridge deck, were calculated at approximately 40mm at both abutments. Thus, a continuous single element armoured nosing expansion joint was used at the abutments.

The project enabled the employment of fifteen local labourers in total. Through a learnership and training program, the contractor provided in-service mentorship to three local students, as well as mentorship to local contractors via the contract. In addition, the local labour employed were trained in steel fixing and paving.

This project was completed three months ahead of schedule within budget. ✦

TEAM

Location: Umlazi, KwaZulu-Natal
Categories Entered: Infrastructure up to R100 Million Value | Innovation & Invention in Concrete
Submitted By: Naidu Consulting (Pty) Ltd
Client/Developer/Owner: eThekwini Municipality Water and Sanitation Unit
Project Manager/Principal Agent: Naidu Consulting (Pty) Ltd
Structural Designer: Naidu Consulting (Pty) Ltd
Social Facilitator: Khanyisa Projects
Specialist Sub-Contractor: Afrostructures (Pty) Ltd
Specialist Sub-Contractor: Resocrete
Specialist Sub-Contractor: Freyssinet (Pty) Ltd
Specialist Sub-Contractor: Civilcon (Pty) Ltd
Specialist Sub-Contractor: Wepex
Concrete Supplier: Métier Mixed Concrete (Pty) Ltd

Entry

Ezulwini Referral Private Hospital

PROJECT DESCRIPTION:

Ezulwini Referral Private Hospital (ERPH), located in the Kingdom of Eswatini, is a three-story tall concrete framed building supported on Continuous Flight Auger (CFA) concrete piles.

The brief was simple; develop a hospital facility that could efficiently serve the Kingdom, whilst limiting the need for expensive transfers and cross-border movement for residents seeking medical attention. The infrastructure needed to provide an all-rounded service offering, meant that the design team needed to come up with flexible, innovative, and cost-effective ways of using every resource with diligence and care.

Nestled comfortably along a stretch of road that has become known as a development hub in the Kingdom, the hospital site lends itself to extraordinary views of the Ezulwini Valley, taking in unprecedented scenes from all sides. The design team took advantage of the location and created a building with an unmatched tension with nature, and through it- creating a healing environment unlike any other.

This impressive building consists of approximately 7 700 m³ of concrete, exclud-ing the concrete hardstand surrounding the building. The project has over 675 tons of reinforcement, a site area of approximately 13 220 m² and a construction area of 16 075 m².

CONCRETE DESCRIPTION:

Concrete was chosen as the primary building material for its durability and resilience to the elements, but also because the local construction industry was familiar with concrete construction.

The structure has various world-class off-shutter concrete finished elements namely: coffer canopy slab, pedestrian- and vehicular ramps, modern Y-columns supporting louvres around the perimeter of the structure, and staircases. The unreinforced concrete hardstand of 3 760 m² is used as the parking area around the structure.

All the non-load bearing walls internally and externally consist of hollow concrete blocks chosen for their lightweight characteristic, as well as being fire resistant.

In the main building the spans consisted of roughly 6-7 metres and the soffit of the slabs was nonexposed with service ducts that were required to run as close as possible to the slabs. Therefore, the choice was made to use flat slabs for the main building.

The vehicular ramp's requirements were a slender slab to ensure the clearance height for parked vehicles, with few services running below. Louvres were required to extend to the soffit of the slab. Therefore, a slab with beams was selected. The slab spanned across the beams in a simple one-way spanning design.

The coffer slab approach for the entrance canopy, spanned approximately 10 m, with no services underneath the slab.

The structure was founded on Continuous Flight Auger (CFA) concrete piles.

The mix design submission not only ensured that the concrete supplier was aware of the specifications and performance requirements of the concrete but served to provide a critical quality control aspect of the project. It allowed the project team members to review the documentation and offer comments before concrete placement. This was key for the project as in some cases the Contractor placed more than 220 m³ of concrete in a single pour.

Slump, Vebe and in-situ density tests were done on the fresh concrete. Concrete cubes were taken for compressive strength tests.

Curing compound was applied to all horizontal surfaces and a combination of compound and plastic sheeting was used for vertical elements.

The contractor and the structural engineer carried out post concrete inspections to check for honeycombing and other defects that would have affected the quality of the finish and the engineer instructed on the appropriate remedial works.

No concrete was allowed to be poured above temperatures of 32°C as per SANS 2001-CC1:2007.

An F2 type off-shutter finish was selected for all exposed concrete area, which stretches to more than 1000 m² of surface area.

A class II mortar, used for normal load-bearing applications, was used due to the tough climate of the region., with an air entrainer / retarder agent, to improve the resistance to freezing and thawing.

TEAM

Location: Lobamba, Ezulwini, Kingdom of Eswatini
Categories Entered: Buildings > R50 Million Value
Submitted By: Pierre Badenhorst Egineers Inc. (PBE)
Client/Developer/Owner: Health Group Ltd
Project Manager/Principal Agent: Clinix Health Group Ltd
Structural Designer: Pierre Badehorst Engineers Inc. (PBE)
Architect: Tag Designs (Pty) Ltd
Specialist Sub-Contractor:FMC Projects Civil & Structural Engineers
Specialist Sub-Contractor: Stefanutti Stocks Construction Swaziland (Pty) Ltd
Concrete Supplier: Stefanutti Stocks Construction Swaziland (Pty) Ltd

Entry

IQ Brooklyn Apartments

PROJECT DESCRIPTION:

IQ Brooklyn is a prestigious, luxurious new development in the heart of Brooklyn, Pretoria. It aims to raise the benchmark in luxury apartments for students and young professionals. It is ideally situated in Brooklyn, with the University of Pretoria to the north and the beautifully attractive suburbs of Groenkloof and Waterkloof to the south. It has easy access to some of the country's most exclusive eateries, shopping malls, embassies, and upmarket residences.

The development includes the design of five reinforced concrete framed buildings consisting of a basement level, a ground level parking deck and six residential levels for blocks 1, 3, 4 & 5 and four residential levels for block 2.

Basement to ground floor level employs a flat slab system with column grids spaced to allow an economical parking grid. On first floor, a transfer level was employed to transfer from the parking grid to the apartment grid. A swimming pool and "tear-drop" shaped openings enhance the aesthetic appearance of the communal area.

IQ Brooklyn incorporates the foremost worldwide trends and energy-saving design. From meeting rooms to a computer and copy centre along with a sparkling pool and Sun Deck in the recreational area, the biometric access control and secure parking all contribute to IQ Brooklyn being a development for the discerning buyer.

The modern designs display the progressive thinking required in keeping with leading advances and research in global architecture associated with today's modern lifestyles. IQ Brooklyn incorporates the foremost worldwide trends and energy-saving design and comes standard with facilities like optical fibre internet access, pre-paid metering, central DSTV, a laundry service, Starbucks-style lounge and cafeteria. Exceptional finishes of the highest quality, combined with elevated ceilings, en-suite bedrooms and open-plan living areas combine seamlessly to give a sense of sleek, ultra-modernity that plays with space and light.

Superbly built and designed for the discerning, IQ Brooklyn is about transforming daily living into beauty and sophistication. ✦

CONCRETE DESCRIPTION:

Starting on the transfer level, 160 mm thick concrete shear walls act as the structural frame in lieu of the conventional column and beam systems. The concrete shear walls enable thin one-way spanning slabs to be used from second floor upward.

The residential layout was designed to match the column grids. This allowed the grids of the residential units to be reduced to 5.6 m centre to centre. With a 5.6 m grid spacing, thinner 200-mm thick slabs could be achieved with reinforcing of about 75 kg/m^3. This resulted in large material cost savings given that a larger spacing of about 7.6 m to 7.8 m would have resulted in thicker 340 mm slabs with reinforcing of about 110 kg/m^3.

The basement was constructed using lateral support "soldier" type piling on the property boundary to avoid collapse of adjacent properties while maximising basement area.

Concrete was an obvious choice for this building because of its long life-span and few maintenance requirements. It was also selected for its strong compression and non-combustible advantages. The concrete mix design involved aggregate, cement and a water-cement ratio just right to obtain the strength of concrete required, with a lower water content to achieve higher concrete strengths. Different concrete strengths were specified for different structural elements.

TEAM

Location: Pretoria, Gauteng
Categories Entered: Buildings > R50 Million Value
Submitted By: EDS Engineering Design Services (Pty) Ltd
Client/Developer/Owner: Uniqon Wonings (Pty) Ltd
Project Manager/Principal Agent: Uniqon Wonings (Pty) Ltd
Structural Designer: EDS Engineering Design Services (Pty) Ltd
Architect: Atrium Architects cc
Concrete Supplier: Triple Drie Beleggings (Pty) Ltd t/a Triple Drie Concrete

Entry

Irene Precinct Building B

PROJECT DESCRIPTION:

Irene Precinct Building B is located in a prime position on Impala Avenue, just off the Botha Avenue Interchange. This mixed-used development offers 6800 m² of premium office space and was designed with 2 basement levels, 4 office levels with roof and upper roof. The façades are finished with a combination of glazed aluminium windows, off-shutter concrete boxes and texture-coated walls.

Class 1 off-shutter concrete boxes were introduced to eliminate costly finishes and future maintenance. To achieve a neat product many challenges were identified for which solutions were found. To overcome these challenges, a team approach was required. The best

design of reinforcement, formwork and concrete was discussed and agreed. Several test panels were then constructed for assessment and approval. The perfect rate and method of concrete placement, concrete compaction, colour variations and concrete mix design was identified.

The first floor slab on which the boxes rest, was extended and propped 9.50 m above bearing level, reinforcement, spacers, boxes and coupler bars were put into position, formwork panels were lifted and fixed. Concrete was placed by means of crane with concrete bucket and chute at rate of 4 cubic meters per hour. A micrometer was placed on the soffit days after casting to monitor movement.

CONCRETE DESCRIPTION:

This seven-storey development is sitting on t-shaped foundation beams, ground beams and strip footings with conventional slabs and beams right through.

Potential challenges were identified and addressed during the project. These included: uncontrolled weather conditions, the formwork of vertical elements and fixing methods to minimize deflection, perfectly lined up ferrule holes, damage to the form face when placing concrete, the rate and method of concrete placement so that lateral pressure in the formwork design was not exceeded, and the time of stripping and uneven curing.

This building received a 4-star design rating from the Green Building Council. Sustainable building features that contributed towards this rating included:

- A waste management plan through which more than 70% of demolition and construction waste was saved from landfill through reuse/ recycling,
- More than 30% replacement of Portland cement by supplementary cementitious materials for all concrete used in the project which allowed for the reduction in mining of natural resources and Green House Gas emissions associated with cement production,
- At least 20% of all construction materials that were selected for the project were sourced and manufactured within a 400 km radius from the site, reducing the impact of long-distance transportation emissions on the environment.

Off-shutter concrete boxes (as nominated) was introduced to meet client needs, providing a cost effective, durable and aesthetical appealing feature to the building. As a result, costly finishes and future maintenance were eliminated. A Class 1 finish was specified, making the task a challenging one.

Areas of special attention included the wall thickness, size, and number of reinforcement bars to avoid congestion (still meeting design requirements) for concrete to be compacted properly and avoiding corroded reinforcement which may discolour the box face.

The concrete mix design had a specified strength of 30 MPa with 19 mm aggregates, cement/ water ratio of 1.85 and a waterproofing admixture. No additional water was added on site, with the slump tolerances, bleed characteristics, and colour control identified.

Basement 1, ground- and first floor slabs were constructed with the slab formwork of first floor extended past the edge propped at approximately 9.50 m above bearing level. The formwork boxes were built and prepared off-site. Dummy ferrule cones were introduced to ensure a consistent pattern on the face.

A smooth and uniform finish was achieved over the large area of the off-shutter concrete boxes. Class 1 is generally specified for smaller elements, where in this case the team poured concrete boxes of 156 cubic meters and 29 tons of reinforcement in total. ✦

TEAM

Location: Centurion, Gauteng
Categories Entered: Buildings > R50 Million Value | Innovation & Invention in Concrete
Submitted By: WBHO Construction (Pty) Ltd
Client/Developer/Owner: Abland (Pty) Ltd, Giflo (Pty) Ltd, Som (Pty) Ltd
Project Manager/Principal Agent: Nsika Architecture & Design (Pty) Ltd
Structural Designer: DG Consulting Engineers (Pty) Ltd
Architect: Nsika Architecture & Design (Pty) Ltd
Specialist Sub-Contractor: Pre-Form (Pty) Ltd
Specialist Sub-Contractor: RMS a Div of Capital Africa Steel (Pty) Ltd
Concrete Supplier: Métier Mixed Concrete (Pty) Ltd

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King Edward VII School (KES) Aquatic Centre

PROJECT DESCRIPTION:

The King Edward VII School (KES) Aquatic Centre, in Houghton Johannesburg, comprises the redevelopment of the previous uncovered aging school swimming pool where portions dated back to 1927, into a world class aquatic centre to be used for the swimming and waterpolo learners of both the high and junior schools.

The architectural design maximised the existing swimming pool site to encompass a new 2 750 m^2 covered yet naturally ventilated aquatic centre to include two large new pools plus a learn-to-swim facility. Within the covered area, a new double storey adjoining structure houses the changing rooms, upper viewing platform and plant rooms while keeping and upgrading the original 1920's northern entrance - a structure with significant heritage value to the school. A focal point of the development is the intricate feature roof with clear spans of 38 m over the pools and an intriguing, stepped apex in plan creating an unusual form and space.

The collaborative and iterative design process resulted in concrete being used extensively and it forms an integral part of the building.

The KES Aquatic Centre proved that upfront collaborative design engagement can result in a combined architectural and structural engineering solution that not only compliments the original intent of the Architect's design but enhances it, with concrete being proposed and used to benefit both.

CONCRETE DESCRIPTION:

This project includes portal frames and support columns to the long span structural steel roof incorporating high-capacity Peikko COPRA cast-in anchors used for the first time in Africa. Each portal frame and the opposing support column were cast in one cast each without joints using specialized steel shuttering to create the finished sculptural elements. The feature roof of structural steel and reinforced concrete elements has an apex of consistent height above the pools to slide on plan by 20 m over the 56 m length of the roof, or 360 mm shift per metre length.

Reinforced concrete was used for the two large pools to ensure the desired shape of the pools could be met, plus ensuring watertight shells with the addition of a waterproofing admixture.

The Centre has a reinforced concrete frame. To create a unique and contrasting feature to the lighter and slimmer long span roof, a feature "diving" architecturally exposed RC column and cantilevering beam was proposed for the internal support of the roof rafters. Standard RC beams and external column completed the eastern support frames. Nine of these frame elements were repeated along the length on the building on grid at a typical spacing of 6 m.

On the eastern and western facades between the feature RC frames and columns a set of concrete eaves beams were added, in two braced bays to provide a reinforced concrete portal frame in the north-south direction for stability.

To limit the depth of the roof structure the design chosen was a double portal frame, namely the 38 m span portal over the pools and the shorter 9.335 m span portal over the eastern block.

The final element of the superstructure was the suspended first floor of the eastern block creating an elevated viewing platform for the pools above the changing rooms and housing the heat pumps for the water heating system above the pool plant rooms. To eliminate vertical supports in the plant room and enable flexibility in the changing room design, a flooring solution capable of carrying the 650 kg/m^2 imposed loading over the 9 m clear span was required. To provide this one-way spanning solution, a precast prestressed concrete hollowcore plank and in-situ structural topping system was proposed. These planks were supported on either loadbearing brick walls or on in-situ RC beams where openings were required at ground level. This provided a prefabricated solution that was lighter than an in-situ solution and faster to construct with an optimal load capacity to weight ratio for a concrete slab solution over this span.

Entry

Below the superstructure a standard concrete surface bed with typical joints on compacted fill was designed for all ground floor slabs. The superstructure was supported off deep piled foundations – cast in-situ reinforced concrete augured piles with reinforced pile caps and ground beams. The RC ground beams along the eastern and western façade between supporting piles on grid acted both as the vertical support of the façade brickwork and the horizontal restraint via passive earth pressure to resist the base horizontal thrust of the roof.

The design addressed sustainability on various levels: the appropriate use of materials to reduce material use and waste; blended concrete mixes were used to reduce the embodied carbon footprint of the concrete; and attention was to paid to detail to reduce the need for over-cladding, dropping the material usage as a whole.

TEAM

Location: Johannesburg, Gauteng
Categories Entered: Buildings up to R50 Million Value | Innovation and Invention in Concrete
Submitted By: Akhane Construction (Pty) Ltd
Client/Developer/Owner: King Edward VII School
Project Manager/Principal Agent: Shed Architecture + Design
Structural Designer: Webber Civil & Structural Engineers
Architect: Shed Architecture + Design
Specialist Sub-Contractor: Concrete Slab Supplies (Pty) Ltd
Specialist Sub-Contractor: Form-Scaff – A division of Waco Africa (Pty) Ltd
Specialist Sub-Contractor: Peikko South Africa (Pty) Ltd
Specialist Sub-Contractor: Penetron South Africa (Pty) Ltd
Concrete Supplier: Métier Mixed Concrete (Pty) Ltd

Entry

Prieska Precast Facility

PROJECT DESCRIPTION:

Wind energy is a renewable energy to assist with decreasing use of Coal Power Plants. The Northern Cape is known for strong consistent winds throughout the year making it perfect for a windfarm. Steel towers can only be erected up to 80-m tall. Concrete towers make it possible to go higher than 80 metres

The windfarm developers decided that locally produced concrete towers would be the most viable solution. Considering that these wind towers will stand 100 meters tall, the main advantage is that the average wind speeds are higher and less variable when towers are taller.

The location of the precast factory is about 70 km from the windfarms called Copperton and Garob. The selected location was based on the availability of reliable municipal services, access to public roads and correctly zoned land that ensured the factory could be established relatively quickly.

CONCRETE DESCRIPTION

The amount of steel in the moulds and the curvature of the moulds necessitated the use of self-compacting concrete. The concrete was designed to reach a strength of 75 MPa.

The segments could only be stripped at 25 MPa and to ensure segments could be cast every day, the concrete was designed to reach this strength at 12 hours. The segments could only be transported to the windfarm and erected when reaching 67 MPa, this occurred between 7 and 14 days.

A -3 mm sand from the same source was introduced to make the mix more consistent and less sensitive. All aggregates delivered to site were blended with the previous stockpile and gradings were done before the material was used in the concrete. The high temperature and low humidity made it a challenging environment for self-compacting high-strength concrete.

The supply contact eventually required the manufacturing of 1 360 100-meter-high concrete towers each consisting of 17 segments and produced from five differently shaped and designed segment types. Each segment is 20 meters high and uses an average of 20 m^3 of concrete.

A 120 cubic meter per hour batch plant was set up with its own aggregate sheds together with a 75 cubic meter per hour backup batch plant and fully functional concrete laboratory.

The factory was built to accommodate two segments of each of the five types of sections to be cast per day. Under-roof mould pits were sunk to below factory floor level to allow for straight discharge of concrete from a mixer trucks. Steel reinforcing was prefixed inside the factory, whilst the top moulds were temporarily stored outside the factory after demoulding. The storage areas are outside of the factory to ensure for easy loading. Traffic management was well designed and orchestrated to allow for free movement of vehicles, ready mix trucks as well as four 64-ton gantry cranes.

Twenty-four-hour shifts were required to allow the reinforcing steel cages to be pre-assembled, placed into the moulds and concrete to be cast in the segments to produce 43 segments per week. The storage area was built to accommodate 4 segments of each type with a total storage capacity of 136 elements.

At the start of production in January 2020, the combination of high cement content of the concrete mix and the high ambient temperatures caused the concrete to set quickly and could have introduced cold joints in the segments. A decision was made to use the backup batch plant in conjunction with the main batch plant ensure that two trucks was released within minutes of each other to reduce the risk of concrete setting too fast and causing a cold joint. In summer months the casting of concrete started at 4:00 and combined with the increased concrete supply rate, ensured segments were complete before ambient temperatures had an effect.

During winter months the extreme cold temperatures caused the freezing of water and admixtures. This forced the site team to only commence with concrete activities at 10:00 for the months of June, July, August, and September.

The design requirement limited the type of coarse and fine aggregates that could be used. The only fine aggregate material available in the area is mechanically produced Dolerite. The challenge at the start of production was that the lack of fines in the -5mm aggregate as well as the inherent variability in mechanically produced material resulted in an unforgiving and very sensitive concrete. Once a -3mm sand from the same source was introduced it assisted with a more consistent mix. ✦

TEAM

Location: Prieska, Northern Cape
Categories Entered: Infrastructure > R100 Million Value
Submitted By: WBHO Construction (Pty) Ltd
Client/Developer/Owner: Nordex Energy South Africa Ltd
Main Contractor: WBHO Construction (Pty) Ltd
Specialist Sub-Contractor: Chryso SAF (Pty) Ltd
Specialist Sub-Contractor: Raumix Aggregates
Concrete Supplier: AfriSam South Africa (Pty) Ltd

Entry

PrimX Future Ready Joint Free Flooring

PROJECT DESCRIPTION:

This project was the construction of a Crossdock Warehouse floor with a maximum mezzanine / sorter load of 192 kN, and a main maximum rack load of 123 kN back-to-back 246 kN. This floor design had to span a 5 m sinkhole.

The 110 000 m^2 project required a high-quality concrete slab to minimize the total maintenance budget of the facility, and a short as possible construction schedule also was a demand from client. Since the joints cause the main part of the maintenance costs – repair works (deteriorated joint edges etc.), damage to equipment, i.e. forklifts and other driving units etc., it was decided to implement a jointless concrete flooring solution.

The solution – a jointless steel-fiber reinforced concrete system based on material chemical compressive pre-stress was used to cast 2300 m^2 jointless panels (basically areas limited by day casting capacity, separated by tight joints). The floor was designed under the system' s worldwide patent.

The compressive pre-stress system allows the concrete to have a stronger material and stiffer section along with improved shrinkage control. Due to high dosages of the highest quality steel fibres, the slab can be built without traditional reinforcing thus ensuring a shorter construction schedule.

The was the largest industrial warehousing project in South Africa in 2020, featuring a massive 110 000m^2 jointless concrete floor, with an expected saving of up to 80% on floor maintenance.

CONCRETE DESCRIPTION:

A quality concrete with a control over the negative effects of shrinkage is at the heart of any successful jointless concrete floor.

Local cement and aggregates were rigorously tested to ensure an optimal mix. The technology and its processes improve ordinary concrete by enhancing the tensile strength and flexural behavior and by reducing the drying shrinkage thus allowing for jointless slabs with thickness reductions up to and exceeding one half the thickness of other common slab systems. Mechanical characteristic improvements are realized through the controlled addition of high-quality steel fibres, while shrinkage control is accomplished by both by careful mixture design and the addition of proprietary concrete additives.

The joints that deteriorate over time due to shrinkage bear the greatest expense and are a problem for any facility due to uncontrolled shrinkage, which induces joint movement whereby the joints open and the slab begins to curl. When forklifts drive over these curled joints, the result is the damage and destruction of the joints, causing excessive repair costs for the customer.

By allowing for large panel construction of 48 m x 48 m, thousands of meters of joints have been eliminated that would have traditionally been part of this type of project. The large panel construction once placed flat, stays flat for life delivering a smooth and lasting finish with zero curling guaranteed.

The vitally important factor of shrinkage and its long-term negative effects has culminated in the creation of a composite material that has ZERO shrinkage, so that large jointless panels with an expected greater than 80% lifecycle maintenance cost reduction on the project budget can be achieved.

The success of the project was defined by attention to detail and a real focus on people and people development by providing knowledge locally and upskilling the local labor force.

On this project, laborers from the local community were all schooled in the art of quality concrete control. ✦

TEAM

Location: Kempton Park, Gauteng
Categories Entered: Buildings > R50 Million Value | Innovation & Invention in Concrete
Submitted By: Primekss SIA
Client/Developer/Owner: DSV Logistics – Global Transport & Logistics
General Contractor: WBHO Construction (Pty) Ltd
Structural Designer: DG Consulting Engineers (Pty) Ltd
Architect: DBM Architects (Johannesburg) (Pty) Ltd
Specialist Sub-Contractor: CHC-SA Concrete Floors
Specialist Sub-Contractor: Global Power Civils
Concrete Supplier: PPC Ready-mix

Entry

The Mpumalanga Division of the High Court

PROJECT DESCRIPTION:

The Mpumalanga Division of the High Court, situated in Mbombela, Mpumalanga, is the first of its kind in the province, standing its ground as a monument within itself, a landmark that brings identity to the once small town.

Due to the nature of the design, an exposed sanctuary for the public, it was only fitting that the exposure notion was carried through to the materiality. To represent the courts as an honest and receptive space, the structure itself was made visible through concrete.

Main concrete features included Artevia and Agilia concretes for achieving Special off-form, Accuracy 1 elements. Due to its high durability and low maintenance, Artevia was the selected material for use in high traffic public areas and vertical circulation. Once cured, it was ground down and polished to achieve a glossy yet slip-resistant finish.

To maintain the quality of exposed concrete, without compromising the architectural intent (such as discolouration over time), a coating was applied internally and externally. The coating allows the concrete to breathe but seals it from external moisture ingress and soiling.

Using concrete as the main feature material in this building, accompanied by ingenious design, has ensured the iconic status of the Mpumalanga Division of the High Court.

CONCRETE DESCRIPTION:

This project and the adjacent building, Mbombela Square, were designed cohesively as to not interrupt the flow and functioning of the precinct.

By using concrete for all the main structural elements, from the slabs and columns to the service cores, public concourse, and main circulation areas, this bastion of justice is complimented by the integrity and strength of the concrete itself. Using concrete for the decorative and functional features of the landscaping softened the approach to the building, creating a successful flow and ease of transition.

The most noticeable features of the building, the six coloured building blocks of justice, were seated with a backdrop of a solid continuous curved concrete wall and of such was the introduction of the curved roof implemented at the main entrance. The atrium of the administrative building was constructed entirely of concrete.

The landscaping features purpose-made 600-mm diameter hexagonal segmented concrete bollards. Concrete paving and precast concrete kerbs were used to successfully link the exterior to the building. Solid concrete panels were thoughtfully placed into the landscape.

The concrete base of the bench pushed the innovative envelope with a trial-and-error approach that was taken to achieve a smooth and aesthetic finish. Due to these three modular elements being so small in comparison to the structure, modifications had to be made to guarantee a high-quality finish that formed a relationship with the exposed concrete.

To speed up the process and with the challenge of adhering to the horizontal required formwork lines, the lift shafts were cast first for referencing and then the floor slabs, with the steelwork dowelled into the lift cores, followed. Horizontal concrete lines defined the entire procedure and had to tie in with vertical elements. Care had to be taken with the shutter work as it defined the success thereof. The correct specifications for release agents and curing compounds were vital to the surface finish of concrete as the substrate off-shutter quality has a direct impact on the finish of the concrete.

The curved soffit of the concrete entrance slab was treated like a ramp and was cast slowly with a low slump to achieve the required shape. The gutter position allowed for three concrete pours with construction joints outside the internal view of the space which aided in the impression of a continuous pour.

Concrete was used to celebrate the material in the architectural environment and to promote it as a building material that can be recycled. ✦

TEAM

Location: Nelspruit Mpumalanga
Categories Entered: Buildings > R50 Million Value
Submitted By: Orbic Architects
Client/Developer/Owner: National Department of Public Works and Infrastructure
Project Manager/Principal Agent: Focus Project Management
Structural Designer: Inhlakanipho Consultants cc
Architect: Orbic Architects
Specialist Sub-Contractor: World of Decorative Concrete (Pty) Ltd
Concrete Supplier: Lafarge South Africa (Pty) Ltd

Entry

Tlhabane Square Office Building

PROJECT DESCRIPTION:

Ditiro House, a 4-star green rated office building, houses various government departments in the Northwest province and represents the first phase in the Tlhabane mixed use Precinct, a multi-phased project just outside Rustenburg.

The architects took care to integrate the precinct into the existing street network rather than establish an isolated development or an enclave. The building's stacked geometric forms are inspired by the massive blocks of the Rustenburg granite quarried in the nearby hills. The overlapping arrangement of the block-like forms includes some dramatic cantilevers and delicate shadow lines separating them, which gives the building an impression of lightness, where the massive rock-like forms seem to be floating.

This five-storey building has a gross area of 8 800 m^2 with a concrete roof and a large semi basement for car parking.

Concrete accommodates the non-modular shape of the building which kinks on plan on the Northern and Western side while also being the appropriate application for the extremely large cantilevers supporting full height brickwork.

CONCRETE DESCRIPTION:

This is a concrete framed structure with a square grid of 8 400 mm and the concrete floors are coffer-type, 325 mm deep with strip beams. The concrete columns are 600 mm diameter. The structure is extremely complex with large cantilevers on all four sides. Post tensioning was introduced in the design to control the deflection and concrete columns were added on the outside of the cantilevers to cater for any differential deflections due to the high loads induced from the full height brickwork.

The ground floor and first floor beams (apart from the cantilever beams) and the coffer slabs were normal reinforced concrete. However, this was changed to using post tensioning for the cantilever and strip beams for the remainder of the structure for economic reasons.

The largest cantilever is 6 000 mm; the working load on the corner column at this position being over 200 tons. The soffit of the slab was dropped in this area to produce a depth of beam of 850 mm which could cater for the large bending moments in both directions. Between the beams a void was created by casting a 125 mm lower slab and a similar depth slab at the higher level which was cast at a later stage over permanent shuttering.

The main entrance foyer on the southern side of the building has a triple volume and the 600 mm diameter concrete columns supporting the three floors above are 11 000 mm high and thus very slender and had to be designed to take working loads in excess of 200 tons. The contractor cast these columns very accurately, within only 50 mm deviation from bottom to top.

A 30 MPa mix was specified for the slabs and a 35MPa and 40MPa mix for the columns. A crystalline waterproofing agent and water-reducing admixtures were incorporated in the mixes.

For the second, third, fourth floors and roof slabs, which had post tensioned beams, a 30 MPa concrete was used with a density of 2 776 kg/m^3. After mid-November 2020 when the weather became very hot the mix was changed to provide 30 MPa with a density of 2 682kg/m^3.

A tower crane was erected on a special concrete foundation pad to move materials around. Concrete placing was by pump. The columns were generally constructed by using the crane to take buckets of concrete to the column and generally 10 to 11 columns were constructed in a day. In certain areas the columns were out of reach of the stationary crane and use was made of a mobile crane. ✦

TEAM

Location: Rustenburg, North West
Categories Entered: Buildings > R50 Million Value
Submitted By: Fellows Dube & Associates (Pty) Ltd
Client/Developer/Owner: Public Investment Corporation
Project Manager/Principal Agent: Betts & Townsend (Pty) Ltd
Structural Designer: Fellows Dube & Associates (Pty) Ltd
Architect: MMA Design Studio
Specialist Sub-Contractor: Trencon Construction (Pty) Ltd
Specialist Sub-Contractor: PERI Formwork Scaffolding Engineering (Pty) Ltd
Specialist Sub-Contractor: Mecca Reinforcing (Pty) Ltd
Specialist Sub-Contractor: Cadcon (Pty) Ltd
Specialist Sub-Contractor: Amsteele Systems (Pty) Ltd
Specialist Sub-Contractor: Axiom Engineering Associates Ltd
Concrete Supplier: AfriSam South Africa (Pty) Ltd

Entry

Watt Street Interchange

PROJECT DESCRIPTION:

The belowground BRT station at the Watt Street interchange is part of the City of Johannesburg's Rea Vaya system to integrate and improve public transport facilities. The Watt Street station will serve the Rea Vaya bus route from Sandton to Alexandra, as well as from Parktown to Alexandra. This is the first belowground BRT station constructed in South Africa.

Once completed, the Watt Interchange will stand as a high-quality integrated public transport interchange that will consist of the following key elements: belowground basement loading and offloading bays, commuter information area, designated trunk route and universal accessibility.

To the north of the bus station, the most notable structures are the twin viaduct bridges, resting on 220 end-bearing piles and over 70 footings. The bridges required two very large continuous concrete pours – one in February 2020 and another in June 2020.

CONCRETE DESCRIPTION:

The earthworks for this project were substantial, involving over 100 000 m^3 of material being moved. To limit the impact on the traffic pressure in the area, most of this volume was moved at night while concentrating on concrete structures during the day.

The earthworks allow the bus lanes to descend between reinforced earth walls into the belowground station, above which a new interchange is constructed for mixed traffic.

The first concrete work included the installation of 342 lateral support piles on the southern portion of the main bridge over Pretoria Main Road, each with pile caps on which would rest some 244 precast concrete beams. The ground conditions and high water table necessitated the use of continuous flight auger (CFA) piles.

This section of the project also included installing 18 km of ground anchors, 10 km of soil nails, and 13 000 m^2 of shotcrete. A spine beam in the mid-section is fixed on one end and supports the 37 tonne beams all the way onto the northern bridge section.

The twin viaduct bridges, resting on 220 end-bearing piles and over 70 footings required two very large continuous concrete pours. Fourteen to 17 trucks supplied the concrete pumps during the large continuous pours of around 550 m^3 each.

Thirty-one local small business contractors were engaged over the duration on the project and 246 labourers were recruited from the local community.

During the construction process, the team attempted to generate zero waste of soil material on site. With the site being in a densely populated area, pneumatic rollers were used for compaction instead of the customary vibratory compaction machinery to prevent interference with sensitive equipment at the neighbouring businesses.

The design required an unpropped cantilever wall (where the section goes below ground) to a propped cantilever wall then accommodating the road above where the ramps are going down to the Watt Street interchange itself and then onto a viaduct section.

With the bus station and BRT lanes below the interchange, the span between supporting beams and clearance for the BRT station were critical to the design. As there is no space to place supporting beams underneath the interchange, the chosen long span between supporting beams allows for the two bus lanes as well as the two module BRT stations.

Construction of the spine beam on the columns had to be supported until all beams were placed prior to the deck being cast above it.

Additional scaffolding was required to support the spine beam for the placement of precast beams due to ground conditions.

This was a highly specified project in terms of concrete mix designs, requiring considerable upfront collaboration with the engineers to approve the designs within the SANRAL specifications. ✦

TEAM

Location: Location: Johannesburg, Gauteng
Categories Entered: Infrastructure > R100 Million Value
Submitted By: AfriSam South Africa (Pty) Ltd
Client/Developer/Owner: Johannesburg Development Agency (JDA)
Project Manager/Principal Agent: WBHO/AMC JV
Structural Designer: Hatch Africa (Pty) Ltd
Specialist Sub-Contractor: Nyeleti Consulting (Pty) Ltd
Concrete Supplier: AfriSam South Africa (Pty) Ltd

WATT STREET INTERCHANGE

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