

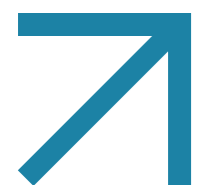
GABENG

ENGINEERING INNOVATION

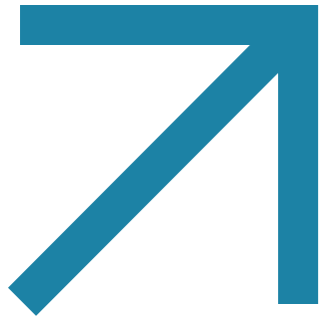
PORTFOLIO

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ELYSÉE TRADE CENTER / 2º ANDAR - TORRES ELYSÉE
RUA RAINHA GINGA Nº39 / LUANDA - ANGOLA



PROJECT MANAGEMENT
ENGINEERING
ARCHITECTURE
CONSTRUCTION MANAGEMENT



About GABENG

Founded in 1991 by Eng. Jorge Flora, former Minister of Construction of Angola (1983-1986), GABENG, Gabinete de Estudos e Engenharia, Lda., is one of the first officially established private engineering companies in Angola. Based in Luanda, GABENG was created to provide integrated solutions in Engineering Studies and Projects, as well as Construction Management and Supervision. With over three decades of experience, GABENG has established itself as a strategic partner in Angola's development, actively contributing to the growth of the construction sector with technical precision and innovation.

Commitment to Quality

GABENG remains committed to delivering services that prioritize excellence, ensuring adherence to the highest quality standards and contributing to the country's sustainable progress.

Multidisciplinary Expertise

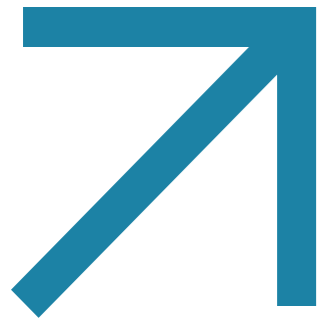
Our technical team boasts extensive experience in executing multidisciplinary projects across Angola. We operate from feasibility studies and project management to the implementation, and management of construction ventures, delivering results that add value to the stakeholders.

At GABENG, each project reflects our dedication to transforming challenges into valuable solutions, contributing to Angola's future.



GABENG

ENGINEERING INNOVATION



AT GABENG,
WE WORK TOGETHER
TO DELIVER SOLUTIONS
THAT ADD VALUE
TO STAKEHOLDERS.

OUR PURPOSE



To deliver innovative and high-quality engineering solutions that drive Angola's sustainable development, ensuring excellence in every project and contributing to the nation's progress through expertise, integrity, and dedication.



VALUES

- **Excellence:** Commitment to the highest standards of quality and innovation in every project.
- **Integrity:** Upholding ethical practices in all our operations and relationships.
- **Sustainability:** Prioritizing solutions that contribute to Angola's long-term development.
- **Client-Centric Approach:** Focused on exceeding client expectations through tailored solutions.
- **Teamwork:** Fostering collaboration within our multidisciplinary team to achieve outstanding results.



WHAT WE DO

At GABENG, we specialize in delivering comprehensive solutions in:

- **Engineering Studies and Projects:** From feasibility studies to detailed project designs.
- **Construction Management and Supervision:** Ensuring efficient and quality execution of construction ventures.
- **Multidisciplinary Project Management:** Managing complex, large-scale projects from conception to completion. By combining technical precision, innovation, and a deep understanding of Angola's unique development needs, we transform challenges into impactful solutions.



DOMAINS AND AREAS OF EXPERTISE

- PROJECT MANAGEMENT
- FEASIBILITY STUDIES
- BUILDINGS AND URBAN DEVELOPMENTS
- INFRASTRUCTURE
- ROADS, HIGHWAYS, BRIDGES & DAMS
- MARITIME AND PORT WORKS
- CONSTRUCTION MANAGEMENT AND SUPERVISION
- PROJECT FINANCE ADVISORY

OUR WORK 

CUNENE RIVER
BRIDGE, **XANGONGO**



Cunene River Bridge, Xangongo

INTRODUCTION

The new Cunene River Bridge is an excellent feat of engineering achieved under extremely challenging conditions. The bridge links the major cities of Lubango and Ondjiva in south-western Angola, and replaces a host of temporary structures that were used to span the Cunene River after the last permanent structure had been destroyed early in the Angolan conflict. The strategic location of the old bridge as the main link between Angola and other southern African countries made it a prime target during the civil war.

The Angolan Roads Agency (INEA) appointed Aurecon, together with its joint venture partners Gabeng and BKS, for the design and preparation of bid documents. This joint venture was also responsible for site supervision. The Angolan Government invested approximately US\$49 million in the project. Construction on the 880 m long bridge began in January 2007, and its inauguration took place on 14 September 2009.

1 Construction of the new bridge over the Cunene River at Xangongo in Angola – view of completed concrete substructure



CUNENE RIVER BRIDGE, XANGONGO

WINNER – International Projects category

KEY PLAYERS

Client Instituto de Estradas de Angola

Professional Team Aurecon in joint venture with BKS and Gabeng

Main contractor China Road and Bridges Corporation



Logistical and natural challenges on this project included landmines, floods during the rainy seasons, the width of the river, lack of skilled labour, difficulty in the acquisition of building materials due to the distance from commercial centres, lack of good aggregates, long supply lead times, importation procedures and border delays.

PROJECT OVERVIEW

The crossing site for the new bridge is located 20 m downstream of the remains of the original bridge structure over the Cunene River, northwest of the village of Xangongo in the Cunene Province. The bridge spans a perennial river channel of approximately 100 m and then crosses the flood plain of the river for a distance of 780 m to the start of an embankment which traverses the remainder of the flood plain. The plain is regularly inundated during the rainy season, which starts from approximately November each year and lasts to the end of March of the following year. For a large part of this period, the flood plain is often inaccessible due to the high level of the river.

DESIGN APPROACH AND AESTHETICS

From the start it was clear that the poor foundation conditions would lead to a bridge configuration with fairly long spans and a deck as light as possible. It was found that a 50 m span length and a composite steel/concrete deck type offered the most economical solution.

The design concept, using precast slab deck and manufactured steel girder sections, also meant that the new bridge could be completed in the shortest time possible.

Hydrology and hydraulics

The Cunene River at this location has a catchment area of 52 400 m². The maximum measured flood occurred in 1951. The peak flood was estimated to be 14 180m³/s and more than 50 years later a higher flood has not been recorded. A free board of 2 m above the maximum recorded flood level was provided.

The river is not very stable and the main channels shift after each flood season. Therefore the bridge had to have an opening long enough to accommodate the different main channel positions.

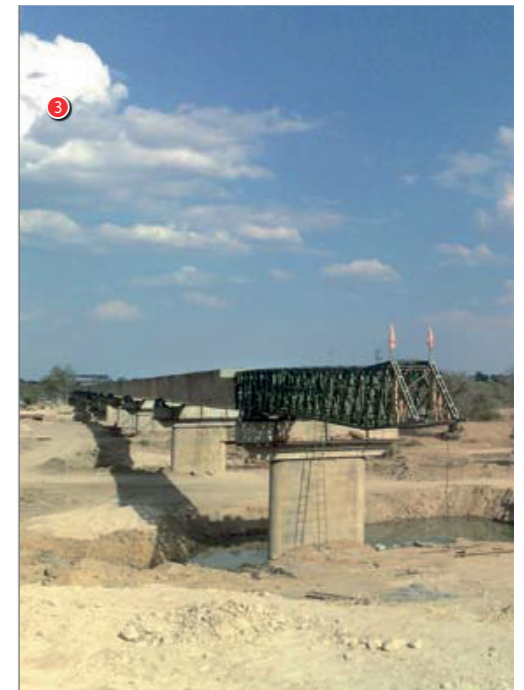
UNIQUE FEATURES

It was important to the Client that the new bridge should be completed by the deadline. This had an influence on many aspects of the design philosophy. The contractor's construction sequencing and turnaround times played a significant part in the detailed design of the bridge works. In this region, concrete aggregate is scarce and has to be hauled from a long distance to the site. This led to the design of an economic solution in the form of a composite deck. The special features of the bridge include:

Composite construction

The choice of a composite construction design utilising structural steel box girders and a concrete deck had the following advantages:

- Reduced weight of the structure which in turn reduced the size of foundations required
- Structural steel substructure could be manufactured in parallel with the construction of the concrete substructure



■ Reduced construction period required for launching of structural steel box girders and no staging and formwork required

Once the structural steel box girders had been launched into position on the concrete substructure, construction of the concrete deck could continue uninterrupted and was not affected by the flooding river.

Concrete precast decking

The concrete deck consists of 1 384 precast concrete elements within situ cast strips in-between. This method reduced construction time, as a large proportion of the deck could be manufactured while the construction of the box girders and substructure was in progress. Construction time of the concrete deck was considerably reduced thanks to the speed of placing the precast elements, and the reduced requirement for formwork before fixing of reinforcement and placing of concrete in the connection strips. Eventually a monolithic continuum deck slab was provided to form the composite section.

Steel box girders

A comprehensive quality assurance regime was put in place to ensure that the highest standards and quality of workmanship was maintained. The contractor engaged a special team of quality control inspectors from the China National Construction Steel Quality Supervision and Test Centre to conduct quality control testing both in the factory and on site. All welds were radiographically and



- 2 Girders being transported in Angola
- 3 Launching in progress
- 4 Precast concrete deck panels on girders
- 5 Completed bridge open to traffic

ultrasonically tested in the factory and on site to ensure the integrity of each weld. Since the girders would spend a long time at sea while being shipped from China to Angola, a comprehensive corrosion protection coating was specified for the structural steel girders.

The use of steel box girders ensured that the biggest part of the bridge could be fabricated in workshop conditions with limited on-site welding. This ensured the quality of workmanship, while the testing of welding was better controlled. Furthermore, the relative light-weight steel construction ensured that the main structural element of the bridge could be launched from one side. The partially precast concrete deck slab with in situ infill panels was advantageous toward the overall construction programme. The manufacturing of precast panels started at the same time as the construction of the steel box girder. Only after the construction of the in situ concrete infill, did the structure behave in a composite manner.

Unusual construction aspects

Foundation
Using a temporary fill, a working platform on the flood plain was created so that piling work would not come to a halt during the five months of the year when the flood plain was inundated. This enabled the 110 friction piles to be constructed

in the shortest time possible. End tipping was the chosen method for the piling works of the bridge abutments. The same method was also used for the piers in the secondary channels of the river.

Deck construction

The construction of 142 box girder sections began in China while, at the same time, 1 384 precast concrete deck slabs were being constructed on site in Xangongo village, Angola. Before shipping the girder sections to Namibe Port in south-western Angola, the girders were pre-assembled in the fabricator's yard in China to ensure fit-up and

alignment of all girder sections. The position of each girder section was noted and marked to ensure proper fit-up and alignment when assembling and welding the girders on site. Upon arrival in Angola, the girder sections were trucked 600 km to site – a challenging logistical undertaking in its own right. An assembly and welding yard was set up on site at one end of the bridge to weld the consecutive girders together. All site welds were ultrasonically and radiographically examined on site to ensure the integrity of each weld. The sections were then incrementally launched using hydraulic jacks from the one end of the bridge.

Concrete deck slabs

The bridge deck consists of precast concrete panels and *in situ* concrete strips designed to act in a composite fashion with the structural steel box girders. The advantage of constructing the deck using precast panels was that the casting of the panels could commence independently and ahead of the fabrication and launching of the structural steel substructure of the bridge. Since this reduced the time required to complete the bridge, the contractor commenced the fabrication of the precast panels well in advance. The 1 384 precast panels were finished in good time, i.e. before the launching of the box girders had been completed.

At the end of February 2009, the contractor placed the first precast concrete deck panels on the box girder and this process continued without interruption until all the precast panels had been placed. Simultaneously, the contractor commenced aligning and levelling the panels in readiness to fix reinforcement and formwork. The first span of *in situ* concrete deck strips was cast on 30 April 2009 and work progressed smoothly, with the concreting of the deck finally being completed on 10 June 2009.

Dimensions

The new bridge is 880 m long, comprising sixteen spans of 50 m each and two spans of 40 m each. The spans are formed by a composite steel and concrete deck structure, with an overall width of 11 540 m, on piers supported on 1,2 m diameter friction piles, up to 30 m in length, founded in a silty clay, and retaining wall type abutments. The concrete deck, which comprises two traffic lanes of 4,5 m each, is surfaced with a 40 mm thick asphalt carpet. Pedestrian walkways, 1,5 m wide on each side of the deck, are provided with steel guard rails installed on the outer edges of the structure for the full length of the bridge. Pedestrians are protected by 1 m high steel guard rails, which are of the collapsible type so that repairs can be made after impact with relatively little reconstruction.

PROJECT CHALLENGES

The following are a few of the many challenges experienced on this complex project:

- Lack of skilled local labour in the region.
- Difficulty in acquisition of aggregates.
- Complexity of construction due to the sophistication of the bridge design.
- Long lines of supply from China and South Africa for the procurement of cement, rebar and other building materials.
- Extremely poor condition of roads which made the 600 km transport from port to bridge site very difficult and time-consuming.
- Communication difficulties – the majority of the contractor's expatriate staff did not speak English and all communication therefore had to take place via an interpreter, who was not a technical person; site meetings often took place in four languages (English, Portuguese, Chinese and Afrikaans).
- The design of the piles for the foundations of the bridge was based on the results of a geotechnical investigation which indicated that bedrock with a suitable bearing capacity was present at a depth of approximately 10 m below the river bed. Based on this, an end-bearing oscillator pile was specified for the project. However, when the contractor began the foundation investigation on site to prove the founding depth for the piles, no hard sandstone horizon was encountered at all, despite drilling down to a depth of 60 m. After consultation with the backstop engineers at Aurecon's office in Pretoria, it was decided to change from an end bearing type pile to a friction type, with a length of between 25 m to 30 m into the highly weathered sandstone and silty clay substrata.

CONCLUSION

Despite all the challenges, the Cunene Bridge was completed successfully and stands proudly in the mighty Cunene River as the longest bridge in Angola. Through the construction of this bridge the uncertainty of commercial and non-commercial transit between the north of Angola and southern Africa has been reduced. During construction the temporary bypass was cut off three times as a result of flood damage to the temporary causeway, bringing traffic to a halt and endangering perishable goods to Angola, as well as the transport of sick people to the main hospital in Ondjiva from the neighbouring villages and towns. □

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LUANDA HARBOUR
PORTO DE LUANDA





WWTP, WASTEWATER
TREATMENT PLANT ↗



COMPLETED PROJECTS

- Development of the Executive Project for the Construction and Rehabilitation of SOBA MANDUME, SUBA, and BRIGADA Streets in Rangel Municipality, under the Strategic Program for the “Construction, Rehabilitation, and Maintenance of Secondary and Tertiary Roads in Luanda Province.”
- Preparation of the Master Plan (Director Plan) for Mussulo Peninsula.
- Development of the Water Supply Master Plans for the cities of Sumbe and Lwena.
- Execution Project Design for the Sewage Drainage Network in the “Morar Project,” including a WWTP (Wastewater Treatment Plant) with a capacity for 5,000 (five thousand) residences (Client: ELISAL).
- Study and Solution Design for the Treated Effluents from the WWTP in the “Morar Project,” involving a 10 km pipeline to the discharge point for ELISAL.
- Preparation of the Execution Project and Tender Dossier for the Roadworks and Stormwater Drainage in the “Morar Project” area in Viana II.
- Design of the Water Supply System for the Army General Staff Facilities – Luanda.
- Reconstruction Project for the bridge over the Giraúl River on the Lubango – Namibe Highway, in a joint venture with CONSULMAR.
- Rehabilitation and Expansion Project for the Facilities of the National Scholarship Institute – Luanda. Consultancy services provided to the National Roads Institute of Angola (INEA).

COMPLETED PROJECTS

- Rehabilitation Project for Road Bridges (transition slabs and abutments) over the Muengueje River and the Sete Irmãos River on the Luanda – Lobito Road, including supervision of the corresponding works.
- Design of a private maternal and child care center in the city of Luanda.
- Restoration and Expansion Project for the ANGONAVE facilities at the Commercial Port of Luanda.
- Restoration Project for three schools and a student dormitory in Caxito, Bengo Province.
- Sanitation Project for the city of Luanda, under the auspices of the World Bank, in collaboration with AFRICON.
- Water Supply Project for the port area of the Boavista Fishing Port and Stormwater Drainage Project.
- Consultancy to the Provincial Planning Office of the Benguela Government and support for this institution in the PRUALB (Urban and Environmental Rehabilitation Project), financed by the World Bank.
- Fixed Asset Valuation (Facilities) for a shipyard of the ECEL firm – Luanda.
- Fixed Asset Valuation (Facilities) for the central yards of the construction company SOARES DA COSTA, S.A – Luanda.
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PROJECT MANAGEMENT

- Supervision of the Construction, Rehabilitation, and Maintenance of Tertiary Roads in Palanca, Streets G, H, and I.
- Supervision of the Multipurpose Terminal at the Unicar-gas Port of Luanda.
- Inspection of the Construction of the Multipurpose Sports Field in Kilamba Kiaxi for the Provincial Government of Luanda.
- Inspection and Supervision of Excavation, Stormwater Drainage, and Paving Works in the Former Warehouse 17 Area.
- Inspection of the Construction of a Children's Center in Kilamba Kiaxi.
- Inspection of the Construction of the Health Center and Maternity Ward in Ramiros.
- Inspection and Repair of the Top Pier at the Port of Luanda.
- Inspection of the Modus Vivendi Building Project (Reinforced Concrete Structure).
- Supervision of the Nova Vida Housing Project, in partnership with the ENEP/AFRICON Consortium.



CONSTRUCTION MANAGEMENT AND SUPERVISION



- Supervision of two primary and secondary schools, a market, a clinic, and a community hall, distributed across the Viana II and Alvorada urban developments in the Province of Luanda.
- Supervision and Technical Guidance for rehabilitation and maintenance works on the National Highway EN100, Barra do Kwanza – Cabo Ledo section, awarded by INEA.
- Inspection of construction works for a neighborhood of 4,000 affordable houses in Viana, near Luanda.
- Supervision and Technical Guidance for rehabilitation and maintenance works on the National Highway EN100, Cabo Ledo Quarry detour – Rio Longa segment, awarded by INEA.
- Supervision of drainage works for the maneuvering and berthing areas at the Boavista Fishing Port.
- Inspection of reconstruction works for damaged areas of the quay structures – Technical Assistance.
- Assessment of infrastructure conditions at the Boavista Fishing Port and preparation of proposals for lease rates, improvements, and other enhancements.
- Supervision and Technical Guidance for rehabilitation and maintenance works on the National Highway EN100, Luanda – Barra do Kwanza, awarded by INEA (National Roads Institute).

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