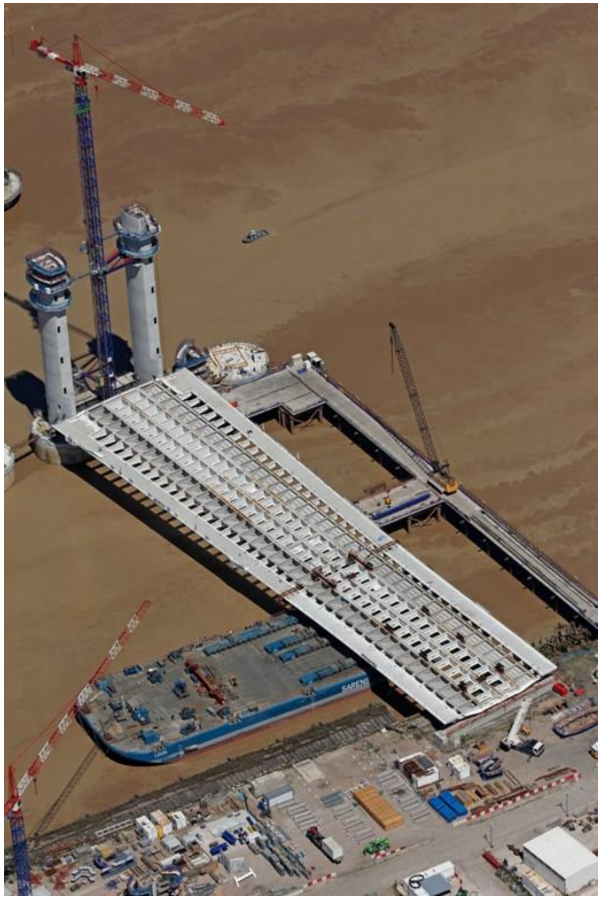
Jacques Chaban-Delmas vertical lift Bridge



LOCATION:

Bourdeax, France

SUBMITTING FIRM:

Egis Jmi – France

FIDIC MEMBER:

SYNTEC-Ingénierie

Jacques Chaban-Delmas
Vertical lift bridge, in Bordeaux (France)

Innovation and creativity for an outstanding bridge

Egis submission - FIDIC Awards 2014

On behalf of the Joint Venture, submission presented by Egis Jean Muller International

BEYOND THE TECHNICAL CHALLENGE

The Bordeaux Lift Bridge is one of the largest lift bridges in the world. This is mainly due to the exceptional proportions of its lift span: 2500 tonnes, 118.70 metres long and 45 metres wide. Its surface area is equivalent to that of a football field which can be raised to 53 metres above the Garonne River in just 10 minutes.

Construction kicked off in October 2009 and was completed on March, 16 2013 with the inauguration of the bridge by the President of France.

The bridge is not only a technical feat on a UNESCO world heritage site, involving important urban and social stakes, enormous environmental constraints and major economic challenges for the city; it is also the result of an on going development policy orchestrated by the contracting authority, the Urban Community of Bordeaux, and Bordeaux City Hall.

The owner's two primary goals for the project were first to provide a much-needed crossing over the Garonne River for cars, pedestrians, and bicycles, as well a potential tram line in the future and secondly to preserve Bordeaux's status as a port city by allowing for the passage of large ships – cruise ships, naval vessels, and historic ships.

AN EFFICIENT ORGANISATION DEMONSTRATING PROFESSIONAL COMPETENCE AND TRANSVERSE ORGANISATION

The team in charge of the design & build project, gathered two subconsortiums:

- **A design subconsortium led by Egis JMI**
- **A construction subconsortium led by VINCI**

The design & build process has established a close relationship between its two partners, while respecting the responsibilities of each of them. The challenges we had to face largely contributed to forming a close-knit team and it is thanks to our motivation, our transverse organisational structure and the openness of our discussions that we were able to overcome them.

A vast array of technical skills was required because the project called on many specialities including road and rail engineering, geotechnics, river and port hydraulics, navigation and wind, structural, mechanical, electrotechnical, electronic, safety, reliability, operating, signage and maintenance studies.

INNOVATIVE CONTRIBUTION OF THE ENGINEERING

This exceptional bridge is intrinsically a prototype; its omnipresent complexity has resulted in an extremely rich spirit of innovation and inventiveness to produce novel yet reliable solutions.

The contributions of the different participants were coordinated by an extremely efficient, well-knit and highly competent engineering team: Egis Jmi, M. Virlogeux, Lavigne & Chéron, Hardesty & Hannover.

The innovation provided by the engineering team can be seen on several levels:

- The development of a system of prefabricated bases and dolphins released directly onto the river bed at the construction site and supported on a deep foundation system reduced the impact on local residents, the river and navigation,
- A high-performance lift design to optimise the lift mechanism dimensions, minimise the installed power and ensure safer control of the lift span movement.
- Installing the lifting components and being able to test them before the lift span was placed in position reduced the construction time by several months,
- The choice of the general design of the mechanisms has resulted in extremely reliable operation,
- The very efficient design of the decks and particularly the orthotropic box girder of the lift span meant that foils could be used to stabilise the bridge under turbulent winds, resulting in greater user comfort for both pedestrians and cyclists,
- The simple, very elegant design of the pylons enabled a multitude of conceptual details to be incorporated into a particularly confined space, that would meet all the service, maintenance and public access requirements.
- The production of a numerical 3D mock-up from the outset facilitated consolidation of the design of elements from such disparate sectors as civil engineering, mechanical engineering and amenities so that the final construction project could be developed. This resulted in a considerable saving of precious time and safety of the general design. The 3D mock-up also enabled us to incorporate modifications resulting from Unesco's comments and instantly measure the operational consequences.

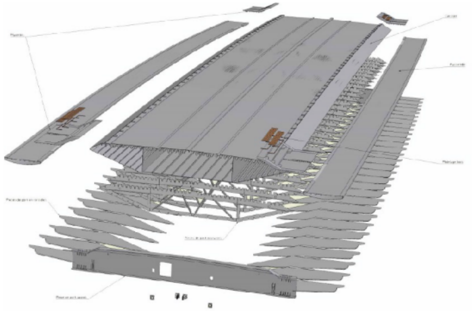
Among all these innovations, we have decided to focus on two major:

AN ORIGINAL TECHNICAL SOLUTION FOR A DECK OF EXCEPTIONAL DIMENSIONS

When designing the 117.4 m lift span which has a total width of 45.1 m, our choices were dictated by the need for minimum weight and very good wind stability.

For the main structure, we opted for a steel box girder with an orthotropic slab comprising three 26.5 m wide by 3.75 m thick cells **whose cross-section is designed to guarantee the best aerodynamic behaviour even under extreme winds, in anticipation of climate changes.**

The box girder was stiffened every 4 m by a triangular structure consisting of cross beams supporting the orthotropic slab, transverse web stiffeners and two diagonal braces. The wind strutting is extended beyond the box girder by large consoles with a span of 15 m.



The metal framework of the lift span was completely fabricated and assembled in the production plant then assembled and transported to the site by barge. Temporary supports were provided to rapidly free the navigation channel for the passage of boats other than large ships, without having to wait for the lift span to be connected to the suspension cables.

The lift span was installed owing to the tide effect: the most reliable, the most cost effective and the most environmental friendly hoisting system.

A HIGH-PERFORMANCE LIFT DESIGN

The design of the lift system is the fruit of our team's long years of experience.

We wanted a design that would optimise the lift mechanism dimensions, minimise the installed power and ensure safer control of the lift span movements. The result is a safe, economical solution.

The bridge operates like an elevator: the weight of the span to be lifted is partly counterbalanced by the counterweights in the pylons; the hoisting winches only need to support the apparent weight of the lift span, i.e. the difference between its real weight and that of the counterweight, which is called the imbalance. The weight of the equipped lift span is 2,500 tonnes and we chose to limit the imbalance to a maximum weight of 100 tonnes, which led to the installation of a counterweight of approximately 600 tonnes in each pylon instead of the 350-tonne imbalance initially required. **This option is not a common practice in the French standards but it is particularly efficient in terms of energy consumption.**

We increased the distance between the bridge bearings on the lift span to provide greater stability. We also designed a special system to lock the lift span in the lower position to prevent it from being raised by heavy winds.

We designed a single pulley at the top of each of the pylons rather than a series of parallel independent pulleys. This resulted in a special hoisting system to install the pulleys and a high concentration of lift cable anchors on the deck.

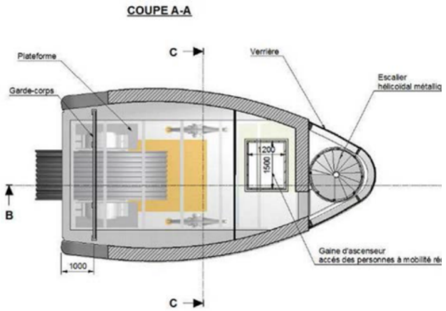
The lift span is displaced vertically over a distance of 46.30 m. A thorough understanding of the pulley and guide requirements enabled appropriate architectural geometrical forms to be designed for the pylons.

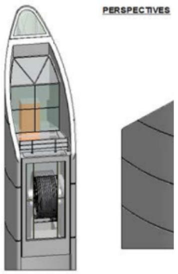
The pulleys were placed at the front not only to make the lift pylons more slender but also so that the lift cables, anchored in two transverse lines, would not be affected by deformation of the deck.

One of the project's main innovations is the lifting device which consists of a counterweight system whose displacement (raising and lowering of the lift span) is motorised in both directions.

The counterweights are displaced vertically inside the pylons. They are driven by independent haul cables (raising and lowering).

These two sets of operating ropes are fixed to the top and bottom of the counterweight and connected to the machinery winches located inside the precasted base, under the river level.



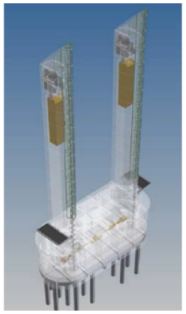


Our design is to be compared with the classical system in which a single cable fixed to the bottom of the counterweight is used to raise the span which descends solely as the result of the high imbalance. This type of system requires very powerful winches due to the high imbalance and results in very high energy consumption.

The principle developed here enabled us to reduce the imbalance, optimize the machinery size, saving considerable costs for construction and maintenance.

In the lower position, the lift span rests on special bearings that enable it to dilate. The piers only have to counterbalance the effects of the operating loads and the imbalance; the suspension cables remain in tension.

During raising and lowering, the lift span is held in position by cushioned guide rollers on three corners. Transverse guidance is provided on the downstream pylons while longitudinal guidance is only provided on the left bank pylons to allow dilation of the lift span at the right bank end.



SUSTAINABLE DEVELOPMENT AT THE HEART OF OUR REFLECTION

Over the last two decades, various ways of crossing the Garonne River have been sought, in order to best meet urban and economic development requirements while connecting up the two banks and respecting the architectural and environmental heritage.
Three types of crossings were envisaged. The first consisted in using the same solution as the Aquitaine Bridge over a distance of 3.5 kilometres while the second comprised the design of a 2 to 3 kilometres tunnel under the river. However, neither of these solutions respected the sustainable development criterion and would have cost 3 or 4 times more than the bridge that was finally adopted.

The lift bridge was by far the best solution and we helped to make that decision. The studies conducted easily demonstrated its advantages:

- Gain of 5 million hours in commuting each year,
- Gain of 29 million kilometres in commuting per year, substantially reducing greenhouse gas emissions and pollution,
- Creation of a major facility to connect up the different transport systems and develop the public transport network,
- Boosting of urban and economic development,
- Improvement of quality of life and reinstatement of the river and port areas within the city centre.

In addition to these major issues, we took initiative to comply on a daily basis with a demanding sustainable approach that guided us in the following design choices:

Reducing inconvenience to local inhabitants and users by:

- Providing regular information, inviting them to witness certain remarkable phases such as sinking of the dolphins and bases,
- Concentrating our main site installations in unused areas on the east bank outside urbanised areas so as to reduce noise,
- Having little or no impact on local traffic along the river bank,
- Not producing environmental pollution on public thoroughfares (construction carried out on a closed site),
- Separating construction areas from public areas ancCarrying out major construction work (dolphins, bases and decks) on remote sites due to prefabrication options.

Reducing inconvenience to port traffic and navigation by implementing the innovations described above, that is, prefabrication of the main foundation components and their direct release onto the riverbed during limited periods of time (if the work had been carried out in-situ, the traffic and safety of river vessels and site workers would have been substantially impacted).

Protecting located fauna by:

- Carrying out limited dredging operations over short periods of time outside the reproduction and upstream migration of fish,
- Carrying out the dredging at controlled rates with piling of materials much further upstream (16 km) on authorised sites,
- Very strictly limiting river work in order not to disturb the flow rate, the fish life or conservation of the river bed.

Protecting and controlling the water by:

- Recovering all waste water for disposal via the appropriate utility,
- Recovering truck waste water to take it to settling ponds,
- Prohibiting discharges of any kind into the river,
- Recovering all washing water used for materials.

Controlling waste by:

- Sorting waste in our offices and on the construction site,
- Storing products and materials in protected tanks,
- Providing oil change pits for civil engineering plant.

The reduction of negative impacts on the construction site is the result of careful reflection, particularly during the design phase.

In conclusion, the design of this major project contributes to the urban integration of two neighbourhoods separated by the Garonne and gives the bridge an urban quality that largely incorporates green traffic and public transport. It helps to reduce pollution in the area and contributes to the pleasure of the people of Bordeaux who can reconnect with their river and admire the façades of Port de la Lune.

ETHICS: ACTIONS SPEAK LOUDER THAN WORDS

Ethics constitutes a common core inside the Group. All Egis companies share common values that are at the heart of our company culture.

Over and above respecting the laws and regulations in countries where Egis operates, the Group has defined a standardised set of rules. These are enshrined in an ethical charter that is available to all, in French, English, Spanish, Romanian and polish versions.

The charter promotes values such as integrity, loyalty, respect for free competition, and transparency. These values support the overall performance of Egis.