LAGOON LEGACY

Segments being lifted into position by the gantry *(Consorcio Ponte de Laguna)*

A bottleneck on Brazil's busy coastal road is finally being relieved with construction of a new bridge at Laguna. **Helena Russell** reports

A new highway link being built in the south of Brazil is attracting a great deal of attention from the country's most senior politicians. Just a week after *Bd&e* visited the site late last year, the president of Brazil was due to make a trip to see how work was progressing on this high-profile project.

The new 2.8km-long crossing consists of a viaduct and a modest cable-stayed span – while it may not be the biggest bridge in Brazil in terms of construction, its strategic importance to the country's coastal road network is undeniable, and the logistical challenges of building it also merit examination.

The Laguna Bridge which is currently under construction in Santa Caterina State will carry high-speed traffic only – there will be no access for pedestrians and it is intended mainly for through traffic. The lake is already crossed by an existing railway bridge which was built in the 19th century but is no longer in service, and a 20th century embankment which carries vehicle traffic. The new crossing, which is costing approximately US$250 million to build and started construction in October 2012, will have a total of 52 spans and a cable-stayed bridge with a 200m-long main span and side spans of 100m at each end.

The bridge is being built for the state authority by a consortium of contractors under the name Consorcio Ponte de Laguna, led by Camargo Correa, which has a 50% stake. The other two contractors, Aterpa M Martins and Construbase both have stakes of 25%.

As well as its strategic importance, the project is also under the spotlight since it features the use of a lifting gantry with optimised prestressing system designed and built by Portuguese maunfacturer Berd. Some 49 of the 50m-long spans will be built using this equipment, and Camargo Correa executive project director Henrique Barroso Domingues explains why this system was chosen to use on the Laguna scheme.

"We have approximately 1,300 people working on the Laguna project; without this equipment we would require even more. It's difficult to find them especially in this part of the country and even civil engineering works are now competing with bridge works for staff. Not only is it more difficult to recruit people, it is more expensive," he says.

"Many projects are going on in Brazil at the moment and we have great difficulty getting enough qualified staff to work on them. The advantage of this type of equipment is that we don't need so many staff so we don't have to rely on finding people who are available and sufficiently qualified to build the bridge using traditional means. This type of industrialised construction system requires a minimum of personnel," Barroso Domingues adds.

"We looked at lots of other different types of methods and machinery and there were lots of reasons why we chose this system. The price, competitivity and flexibility of the system were the main ones. "It's also a very competitive market at the moment, and the Berd equipment helped us to lower the price of our bid by increasing our productivity. We contracted Construgomes, who understand the system, and they are training our own personnel on site to use the equipment which we have bought. We plan to use this equipment for other works in the future," says Barroso Domingues.

The main spans are on the critical path, Barroso Domingues says, and construction of the approach spans is on schedule with cycle times having been cut to just five days.

The bridge construction is currently running to schedule, says Barroso Domingues, although he predicts that this may even improve in the months ahead. "In the long term, I believe that we will speed up and be able to go ahead of our schedule," he says.

He believes that the time savings offered by using this type of equipment was one of the major reasons that the consortium was successful in its contract bid. "The other bidder planned to build the spans using the balanced cantilever method," he reveals, "but this would have taken more time, needed more sets of equipment, and more staff."

The new bridge will effectively increase capacity across the lake at Laguna, which currently presents a bottleneck to traffic on the road – four-lane traffic has to narrow down to two-lanes at the existing bridge, creating constant delays. On any transport route this would be a nuisance, but in this case it is even more serious, given that the highway is a very important link between the north and south regions of the country and beyond into South America.

Client for the project is the national roads authority, and the design of the bridge has been carried out by consultant Enescil. The alignment of the new crossing means that the cable-stayed bridge will be the first curved cable-stayed span in the country. In fact there is no shipping on the lake at the moment which would require such a span, but engineering manager for Consorcia Ponte de Laguna, Weber Chaves, says that this navigation clearance was required to accommodate potential future shipping.

The lagoon which the new bridge crosses is some 33km long, and its presence alone creates logistical problems for the construction work. The majority of the bridge is being built with precast concrete segments, which was a demand by the client in order to reduce the potential impact on the environment at the site. There was not sufficient space close to the alignment of the bridge to build a precast yard, so it has had to be established some 5km away. Not only is the precasting yard and project headquarters at some distance from the bridge, across the lagoon itself, but the only flat space on ▶

Construction of the main towers is now under way

which the yard could be built is on top of a hill. As a result, the precast units will have to be handled by a gantry crane along a 150m-long steel pier which was specially; they are lowered down to water level and placed on barges to be transported to the site.

This is already the case with the concrete being used for the foundations and piers that are being built in situ for the viaduct and also the towers for the main bridge. Concrete wagons load up at the batching plant on the other side of the lake, then drive onto the barges and are sailed across the water to the construction site.

Preparatory works for the contract included dredging at the bridge alignment, and construction of jetties and moorings for the barges that are being used on the contract. A fleet of some 55 vessels is required for marine access to the bridge site, with everything being taken by water to the site because the only route available on land is the main road, which is frequently congested. Even the substantial steel elements that were assembled for the gantry were delivered by this method.

Ironically the support boats themselves even had to be brought by land to the site, since they were too large to access the lagoon by water. According to Chaves, it took about a year to bring all the boats to site and assemble them.

The project headquarters and precasting plant covers a 10ha site which also provides accommodation and facilities for staff. As Barroso Domingues points out, one of the major issues for a project this size is recruiting workers with appropriate skills, and consequently some 70% of the staff come from outside the state. Supplying services such as water to the site is also a complex undertaking, with the project having its own borehole from which water is extracted and treated for drinking, water from air conditioning units being recycled for concreting, cleaning and so on, and rainwater collected for the same purpose.

The bridge is founded on steel tube piles filled with concrete, which are driven to the rock level, up to 70m deep in some places. The piles are 2.5m diameter and extend up to 7m into the rock. Foundation construction is carried out from one of several floating 'islands' made of a number of barges which carry the equipment and materials required. Some 40 piles were required, and more than half had been completed by the end of November 2013.

Although the overhead lifting gantry is being used to erect the majority of the new bridge, there are two sections where the concrete deck is being built in situ – on the first section of the bridge where there was no room for access for the Berd gantry, and on the section where it crosses a railway line, when delivery of the segments from below would have complicated construction.

View from the gantry, showing the existing road embankment and rail bridge

When *Bd&e* visited the site in November last year, work had progressed from the in situ construction to the use of the Berd launching gantry, which can erect a 50m-long span in less than a week. In November work was about to start on the over-water span construction. Work on building one of the towers for the cable-stayed span had already begun the month before, with the second one just about to start.

Construction of the two towers will progress at the same time as the first approach bridge. The launching gantry will be used to build both approach bridges, first one side then the other. The operation to relocate the gantry will be a complex one, since it has to be dismantled and shipped to the other end of the bridge before being reassembled. According to Berd operations manager David Moreiras, five different options for the relocation process were proposed to the contractor, with different cost and time implications, and requiring different types of equipment for dismantling and shipping the gantry. It is up to the contractor to decide on his preferred option.

The main benefit of this lifting gantry design over that of a traditional gantry, Moreiras explains, is that it is not necessary to lift all 14 segments of the 50m span off the barge and into position before assembly begins. As soon as half the segments are lifted, the prestressing system in the gantry can be adjusted to accommodate the remaining seven units and these are then lifted and placed straight into the correct span alignment. Time is saved in the erection process and also in the adjustment process – up to eight hours' saving per span, according to Moreiras. Units are connected to one another using Dywidag bars, and once they are all assembled, the prestressing is introduced across the whole length of the span.

The deck is being built in pieces, with the central box units being erected by the gantry, and precast struts which support the deck being added once the span is complete. Precast planks follow on, with concrete deck poured on top of those.

As *Bd&e* went to press, the LG 50/100 machine in Laguna was building a span each five-day working cycle, and was on the 16th span. With the consortium having programmed the machine to build a span a week, this certainly represents a faster pace and the opportunity to get ahead of schedule. In fact Moreiras believes that efficient working and good organisation would make it possible to build a span in just three or four days using this machine.

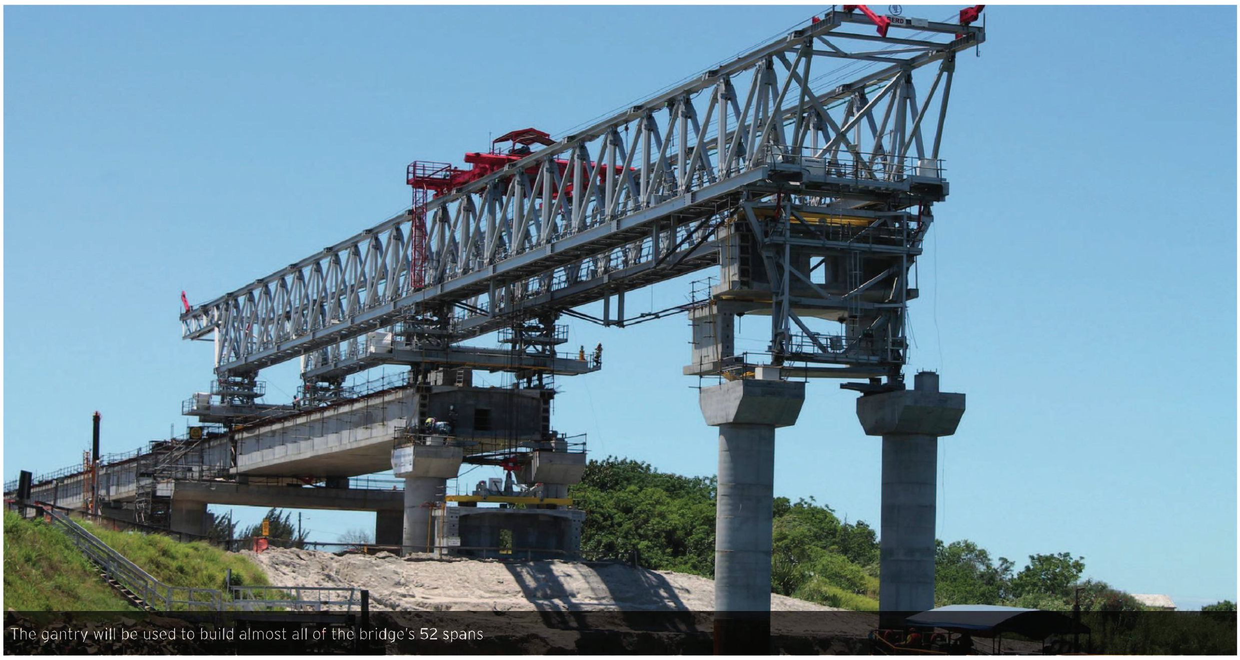
In terms of progress, the relocation process will take some time to complete, and the assembly of the gantry at the other end of the bridge will be complicated by the restricted access. The gantry is 132m long, 9.3m wide and 6.75m high; in its unladen state it weighs 520t.

Additionally the machine has been designed with special anchor points that allow it to be tied down more tightly - this measure was incorporated to protect the equipment from damage by the storms that this part of the country suffers several times a year.

Barroso Domingues is very happy with the service he has received from Berd, and confirms that all the promises made in terms of delivery dates, assembly and progress have been met, right from the time the contract was signed.

"The fabrication of the machine in Portugal, the transport by ship, the importing of the machine, transport by truck to site, and assembly of the equipment on the site, all of it went exactly to plan," he says. Design of the machine began at the start of January 2013 and it was manufactured in Portugal, delivered to the site in Brazil and assembled and tested ready to start construction by the end of August the same year – an extremely short programme, according to Moreiras,

Barroso Domingues also believes that the presence of this very high-tech, modern machinery is one of the reasons why the project has such a high profile nationally. "Such an investment in technology which is now shown to be working well, is good politically for the government," he says ■



The gantry will be used to build almost all of the bridge's 52 spans