Rion rising

First of the lifts to kick off construction of the pylon heads on the Rion Antirion Bridge in Greece took place at the end of January. Bd&e reports on progress of this major crossing

The Gulf of Corinth was the venue for a delicate lifting operation at the end of last month, marking the start of erection of the pylon heads for the 3km long, five-span cable-stayed bridge being built there. When it is complete, at the end of 2004 if everything goes according to plan, the Rion Antirion Bridge will form a vital part of the Greek road network, providing a fixed link over the gulf, which currently has to be crossed by ferry (Bd&e issue no 21).

At the time of writing, the construction site was a hive of activity, and likely to remain that way for the next two years. The last of the four huge pier bases was towed to its final resting place in the 60m deep gulf just over a year ago, and concreting work on each of the four is in various stages of completion. Although the first pylon head lift was a concrete slab, in effect marked the beginning of the steel erection process for the project.

The Rion Antirion Bridge consists of five cable-stayed spans, three of them 560m long, the other two 286m long. The huge concrete piers have 90m diameter bases, which rest directly on the seabed, under which a 3m thick gravel layer sits on top of a network of inclusions which reinforces the poor soil. The legs of each pier rise to a height of some 60m, above which are the funnel-shaped, heavily reinforced pier heads, square in plan.

Four inclined concrete legs, 4m square and also heavily reinforced, are built up in situ from each pier head to their meeting point, above which the steel cable anchors will be installed, bringing each pylon to a full height of some 240m from the seabed.

The pier head (or pylon base) consists of a ring beam some 6m wide by 3.5m deep, forming a square with 40m-long sides. Each side contains 21 post-tensioned prestressed cables which cross each other at the corners - extremely heavily reinforced.

As the pylons begin to rise above deck level the sea-water surcharge inside the piers is pumped out, since most of the anticipated pier settlement has been achieved. The final bridge superstructure weight will be similar to the weight of removed ballast water.

With the contractual date for completion set at 24 December 2004, the project is now starting the penultimate year of the five year construction contract. As Bd&e went to press, main contractor Kinopramia Gefyra project manager Gilles de Maublanc confirmed that construction was still on schedule to meet the completion date.
The most advanced of the four main bridge pylons had just had the first part of the pylon head lifted into position, the four legs of the second were some 75% complete and the remaining two were shuttered up to the top of the pylon head, almost ready to start the pylon base, immediately below deck level.

"We are still on schedule for our completion date," de Maublanc says. "Construction of the pylon legs is so far taking exactly the amount of time that was predicted. Despite the complexities of the doubly-sloped concrete legs, the huge amount of post-tensioning cables to be installed, and so on, they have all been on time."

De Maublanc explains the purpose of the first lifting operation that has just been carried out. "Where the four legs of the pylon system connect there is a concrete slab, this will form the first connection between the four legs and will also be the connection between the pylon legs and the steel anchorages. This concrete slab incorporates the anchor heads for the vertical post-tensioning for the pylon head, which will be stressed back down to the concrete slab."

"The slab is very difficult to form in situ - it also contains certain cast-in elements - and hence it needs to be very accurate. We have designed the slab so that part of it - which will form the bottom of the slab - can be made in the yard. This will incorporate all the inserts too," he says. "Time savings have been substantial; 'We estimate that it has saved us about three weeks in doing it this way,' he says. 'It transfers a lot of work to the yard, and saves a lot of time on the critical path.'"

This element, which weighs about 200t, was placed on top of the legs, at a height of about 135m, in the recent lifting operation. The unit is cross-shaped - about 10m by 10m square but with gaps left for the legs of the pylon to slot into. The final part of the slab will be cast on top of this.

Strong winds have been a constant problem at the site - readings taken by the client onshore before the contract were let turned out to hugely underestimate the wind speeds in the middle of the gulf, where most of the crucial lifting operations will be carried out. The slab lift had to be postponed for several days because of strong winds.

Maritime contractor Smit is providing the lifting capabilities required for this part of the contract. The work requires exclusive mobilisation of Smit's sheerleg Taklift 7 and the anchorhandler Zeeliew, which has a 171 bollard pull, for 575 days. Taklift 7 has been equipped with a jib and a long boom extending to 175m. Additional heavy lift equipment was transported to site by Smit's flat top barge Tak 5.

Taklift 7 arrived at Antirion at the end of last year to begin preparations. The big sheerleg's 130m long boom was installed, and slings and shackles rigged, so that it was ready at the end of January to lift the first pylon head section from the quay and transport it in the hook to the installation site. The craft then connected up to pre-laid moorings before lowering the section into position.

"The barge picked up the slab from the yard and went directly to the pylon where it was to be installed," explains de Maublanc. "At the pylon it anchored itself to winches that were already installed, and manoeuvred itself into position."

The next task for Taklift 7, following the lift of the concrete slab, is expected to result in an even bigger saving in time, as well as facilitating quality control. Large sections of the steel pylon head will be lifted into position as complete units.

Each pylon head has a structural steel core of eleven boxes, each about 7.5m by 2.5m by 2.5m high stacked on top of each other. There are substantial continuous welds between sections, requiring preparation, heating and the application of the right weld. Each section will be lifted into position, which takes about 60 minutes. Once a pylon head is in position, it will remain there until the pylon is complete.
simultaneous use of six welders. The original intention was to use the Potain tower crane on each pier to lift each 25t section separately and weld in situ. But Talilift 7 can lift six sections together from the yard and place the resulting almost 200t load on top of the pylon legs. A second lift will place a further four sections together on top of these, and only the last section on the two highest pylons will need the tower crane as they are above the 160m reach of the floating crane.

It will be some two or three weeks before the first of these will be lifted into place. "They are similar to the lifts we carried out on the Queen Elizabeth II Bridge in Dartford, UK," says de Maulbranct, "although the actual pylon elements themselves are different because the anchorage system is different - more like the Normandy Bridge."

When the construction method for the deck erection was changed, it made sense to use Talilift for the pylon segments too - and with the capacity of this craft, the pylon segments can be lifted in just two operations. The change of construction method for the deck erection was due to a number of factors, explains de Maulbranct. Originally the plan was to lift the deck units using shearlegs mounted on the deck cantilever, similar to the process used on the Second Severn Crossing. As each unit was raised and connected, the shearlegs would be moved forward to the end of the new deck unit ready to raise the next one. Four shearlegs would be required to accomplish this plan, and they had to be designed specifically for the project - no suitable equipment existed. The shearlegs would also have to be designed to cope with seismic forces, should an earthquake strike while a deck unit was being lifted. As the design of these shearlegs proceeded, they kept being redesigned to be stronger and the predicted costs kept rising.

Another factor was that with the use of the shearlegs, the contractor planned to lift steel units without the concrete deck; this would be added in
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On the approach

In October last year, the Greek Ministry of Public Works officially awarded the concessionaire, and simultaneously, the contractor, the extra works needed to connect the main bridge into the existing national road system. The following month, Gephyra and the ministry also awarded the supervision of these extra works to Fabermausell under the same terms and conditions as for the original works.

On the north side the work consists entirely of earthworks, drainage and about 1km of pavement. But preliminary archaeological excavations early last year revealed a Hellenic site of interest - dating from somewhere between 500 BC and 300 BC. Full excavation of the site was carried out during the year by a team of 20 to 30 archaeologists and labourers. Although it turned out to be an extensive settlement, most of the buildings had originally been of poor quality. The site did, however, contain the lower parts of a large number of amphorae used for storing wine and olive oil.

The whole site lay just below present ground level and no building foundations appeared to be more than a metre below ground. When the proposed north/south Antirion to Igoumenitsa road is built," explains Fabermausell project manager Peter Ilay, "it will supercede the road under which the archaeological site is located. As a result, the decision was taken to protect these antiquities for possible future study." This is being done by backfilling the excavations with sand, covering the whole area with a further layer of sand, and raising the new road over it by two or three metres.

The extra works are much more extensive on the Rio side. For environmental reasons a decision had already been taken to redesign some three quarters of a kilometre of approach embankment through the houses as a viaduct, making the road less visible, and reducing its impact in the urban area. However the contractor has been allowed only a year in which to design and build the extra works, hence a design had to be chosen that would be relatively simple and quick to erect on site. The superstructure will consist of two main longitudinal steel beams about 2m deep for each carriageway with cross-girders and on sit concrete deck slab to be cast using travelling shutters. Spans vary from 30m to 62m and columns sit on pile caps supported by 1.8m diameter bored concrete piles up to 35m long.

Since the contractor had been anticipating the award of these extra works for some time, it decided to change the short length of Rio viaduct that falls within the original main bridge contract to the same form of construction. The total length of the viaduct is now a kilometre, making up a total crossing length of approximately 3.5km. This new section of viaduct also includes an interchange, which means that about half the length of each slip road is also on structure.

At present, the works are on schedule for completion a few weeks before the contractual date in December 2004. Ilay believes that it is most unlikely that this date could be further improved, for example to open before the Olympics in August 2004. "Should there be a wish to carry the Olympic torch across the bridge, as is rumoured, on its journey from Olympia south of the bridge via Delphi on the north side of the Gulf of Corinth to Athens, we will have to wait and see if the final gap in the deck can be closed in time," says Ilay.
parts during welding and subsequent adjustments have taken several weeks longer than anticipated," he says, "however, we expect that this time will be recovered before the first unit is erected." Because of headroom restrictions imposed by the temporary buttresses between the pylon legs, these segments will be placed initially onto sledging beams which are already in place and then slid into their permanent position above the pylon base.

The process is further complicated by the fact that not only do these units have anchorages for the permanent dampers and fuses which attach to the piers (the entire deck does not actually rest on any piers but is suspended from the stays only) but there are additional anchorages for temporary stays and ties to stabilise the deck during erection, particularly in the case of an unlikely seismic event.

"Completion of the first pylon segment took place last month (January)," says Platt, "after which the assembly of the second pylon segment began." Completion of this segment was anticipated as Bridge design & engineering went to press.

"Once the assembly has been completed satisfactorily, and the geometrical checks have been made," says Platt, "the segments are handed over to Kinoproasia Gefyra for concreting of the deck slab." Before concreting each segment is again connected to its partners in a similar way to the pre-assembly check described above to ensure that the geometry is unchanged. Before it is finally erected on site, the majority of the segment steelwork will be painted on the assembly line, to reduce the amount of in situ painting work required from gantries. This final stage of each production line will see remedials to primer and undercoat followed by application of full final paint coat, leaving only splice plates to be painted in situ from the permanent maintenance gantries.

Standard deck units can be assembled in one to two days. The four production lines that are now in operation will each produce a completed deck unit with concrete deck slab every week, to match the planned erection rate, working on four cantilevered decks simultaneously, two at each of two piers.

The finished segments - a standard element will be some 325t - will be lifted into place by the floating crane Taklift 7; this process and the initial connection will be carried out under the control of main contractor Kinoproasia Gefyra. Once the initial connection has been made in the temporary connection device, the permanent splice will be made under the control of Cleveland Bridge. The first segment was due to be installed as Bridge went to press, with the final segment planned for installation in summer 2004.

Cables and anchors are to the Freyssinet system, and the contractor has now taken delivery of all cables and anchors needed for the first pylon and associated deck units.

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