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The Antrenas Tubular Arch Bridge

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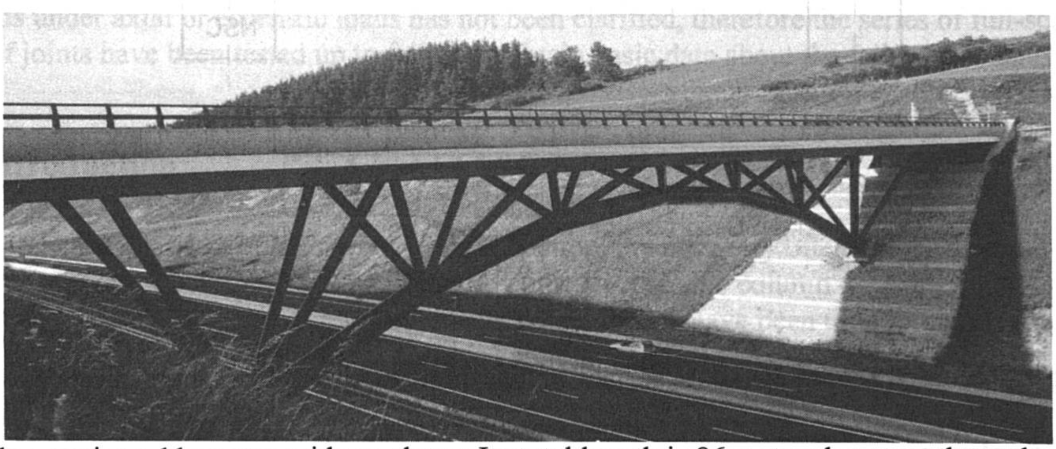
Born 1957, TPE civil engineering degree 1979. He joined SETRA in 1980. Experience in steel bridges and their pathology. He has been involved in the design of innovative composite bridges.

1. Presentation

Antrenas bridge is original and innovative. The tubular steel skeleton is an arch connected to a prestressed concrete slab to achieve a composite structure which is also a truss. Steel arch principal tube is filled with reinforced concrete, which again creates local composite elements.

The bridge is set in a remarkable landscape where the A75 motorway crosses the Gévaudan. The A75 cuts a dissymetrical gap through the granite ridge to a depth of about 15 metres for a width of 85 metres at the top. The western slope of A75 is one metre higher than the eastern slope.



The bridge carries a 11 metres wide roadway. Its total length is 86 metres between the end support axes. It is designed to give the passage to exceptionally heavy 110-ton trucks.

The bridge alignment is straight; it is perpendicular to the motorway axis. The tube keeps a 4.85 metres height clearance for traffic over the entire width of the motorway as well as over the access road. Its longitudinal profile has a one per cent slope.

2. General design

The bridge consists of a single tubular steel arch with a 56 metres long span, whose overall shape is parabolic, with a mean radius of approximately 60 metres. The deck is a ribbed concrete slab. Two longitudinal concrete ribs are supported by steel struts joining arch and deck.

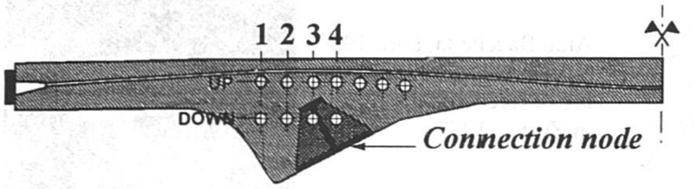
The steel tube of the arch has a circular section with a 1.2-metre diameter. Its sheet is 32 millimetres thick. This tube is located in the transversal symmetry plan of the structure, and rests on foundation blocks embedded in the slopes.

A steel propping system was developed to support the formwork for concreting the deck. Transferring the load from the temporary steel scaffolding props to the steel arch was a delicate operation requiring various jacking sequences.

To compensate the shortening effects of the arch under permanent loads, it was decided to jack it 25 millimetres at each of its springs. This reduced horizontal slipping thrusts in the punctual connection nodes.

The deck has a total width of 11 metres. The slab has a mean thickness of approximately 35 centimetres. At the ribs the maximum thickness is 95 centimetres.

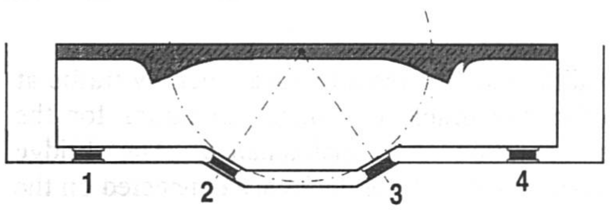
The deck is longitudinally prestressed by seven pairs of 12_T15_S tendons running from end to end. This slab is also prestressed in the transverse direction by 4_T15_S tendons. Two tendons are positioned over each local steel node connecting concrete ribs and tubular skeleton's struts. As shown below, those punctual nodes are sunken in the concrete ribs.

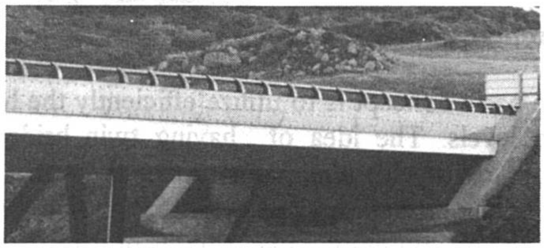


Longitudinal 7 tendons disposition :

4 of them are undulating tendons:
UP : position at connection nodes
DOWN : position between punctual connection nodes supporting deck.

The bearing system at the abutments provides sideways locking as well as taking up the vertical forces. Each cross-beam at the abutments is a counterweight on four neoprene bearings. Shear forces are very low in those neoprene bearings, even in the inclined ones.

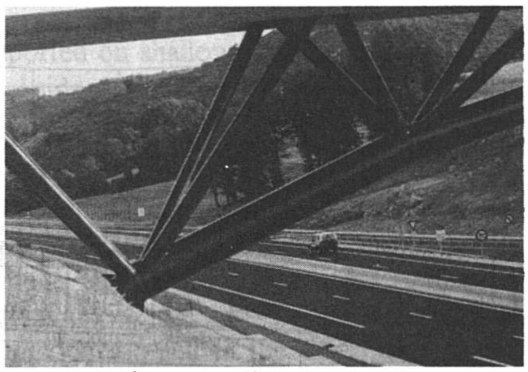




Roles of bearings : ***1 - 2 - 3 - 4 : vertical load blocking***
1 and 4 : torsion blocking - 2 and 3 : lateral load blocking.

3. Design of the tubular steel framework

Because most of the bridge mass is in the slab, and not in the arch, it is preferable to give the arch a polygonal profile, almost perfectly funicular in transmitting permanent loads. Furthermore, from the economic standpoint, a non-developable toric shape could not be achieved under acceptable conditions with a 32 millimetres thick steel sheet.



Straight tube sections were therefore positioned between two successive butt welded joints at nodes.

It was decided to fill the bottom parts of the arch with concrete to improve the structure's resistance to collisions with outsize vehicles.

4. Conclusion

The contract, for a value of 11.3 million francs and an overall execution time of 16 months, was signed with the contractors ***GTM*** and ***Richard-Ducros.*** At a slightly higher cost than for an ordinary bridge, the Project Manager achieved an exceptional structure, well-suited to the landscape topology. In 1995, the Antrenas Bridge, designed by ***SETRA*** received the Silver Ribbon Award from the French Ministry of Public Works. Michel Virlogeux and the consulting architects Dezeuze and Zirk were also commended by the French association of steel-building companies called "Syndicat de la Construction Métallique de France" for an Architecture Prize awarded in the road bridges category.