

viaduc

ÉDITÉ PAR LA COMPAGNIE EIFFAGE DU VIADUC DE MILLAU

May 28, 2.12 p.m.: contact above the river Tarn



distortion. It was therefore vital to join the two halves together as quickly as possible”.

A three-dimensional adjustment

The final assembly requires precise alignment to the millimetre of the two halves of the deck by successive adjustments: horizontal, vertical and finally angular. It should not be forgotten that the bridge is sloping and follows a slight curve. To enable the necessary corrections to be made, the launch is halted 1.2 metres from its destination. Winches are then installed on the northern and southern sections of the deck, and linked together by cables. The purpose is to exert sufficient sideways traction to correct the few centimetres that are out of horizontal alignment. On the other hand, the vertical adjustment is then made in two steps: preliminary work on the stay cables brings the northern section of the deck into the most favourable position possible, the “fine-tuning” then being effected by means of hydraulic jacks installed in the deck. “Finally, to eliminate the angular discrepancy between the two parts of the deck, metal tubes are installed opposite each other on each section”, explains Jean-Pierre Gerner. “Traction bars are then inserted into these cylinders, and hydraulic jacks draw them tight causing them to close together with a perfect alignment of the final connecting joint. All that then remains to be done is to weld the clamps, steel elements which temporarily secure the two halves of the deck together until their definitive welding”.

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The long-awaited connection of the northern and southern sections of the deck took place without a problem on May 28, 2004. It was a moment of intense emotion for the teams on the construction site.

A brief explosion followed by the sound of shattering glass rings out across the viaduct, 270 metres above the river Tarn. However, not a trace of panic can be discerned among the workers who have taken their places on either side of the immense steel ribbon. And no wonder, because when the bottle of champagne explodes under the incredible pressure of the 28,900 tons of the southern section of the deck advancing the last centimetres still separating it from the northern section, joy breaks out on everybody's face. A page of capital impor-

tance in the history of the highest bridge in the world has just been written: the Larzac plateau and the Causse Rouge have been joined together! The technological challenge laid down two and a half years ago has been met: after the finalisation last December of the pillars constructed by Eiffage TP, the teams from Eiffel have in turn carried out their mission. It is just twelve minutes past two on this afternoon of May 28, 2004.

Just as at every stage that gradually brought the two sections of the

deck to come together the final connection followed a meticulously planned procedure. Although the launch, which allowed the last 171 metres to be crossed, did not present any distinctive features in itself, the last decimetres represented an especially important moment. “It was impossible to leave the two parts of the deck suspended for several days a few centimetres from each other in order to carry out the final adjustments”, stresses Jean-Pierre Gerner, the Eiffel director of works. “It would have been damaged by

Jean-Pierre Raffarin: “A historic moment”

“I raise my safety helmet in honour of all those who have worked on this construction site, and to acknowledge the gratitude of the Republic”. For an exceptional moment, an exceptional visitor: Jean-Pierre Raffarin, the French Prime Minister, made a point of coming in person, just a few hours after the temporary connection of the two sections of the deck, to congratulate the performance of the teams who had worked on the construction site of the Millau viaduct. Among the many personalities present were also Gilles de Robien, French Minister of Transport, Chantal Jourdan, prefect of the Aveyron department, Henri Planes, sub-prefect of Millau, Jacques Godfrain, Member of Parliament and Mayor

of Millau, and Jean-Luc Gayraud, president of the Community of Communes. The guest from the Matignon Palace had no hesitation in qualifying the junction as a “historic moment” before crossing the gap of a few centimetres still to be closed between the southern and northern sections of the deck. He then shook hands with the political representatives present on the viaduct before personally congratulating those in charge of the work site. Jean-Pierre Raffarin also took the time to ask them several questions, particularly concerning the safety features of the structure. The visit ended with a brief flight over the structure by helicopter. ■



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The last three centimetres

After a halt of almost three hours necessary for the different adjustments, a shudder as well as a slight swaying reveal that the southern section of the deck is on the move again. A few seconds are enough to cross half the remaining distance. Hands already stretch out towards each other from either side of the deck. It is not long before champagne is flowing above the steel panels. Just a few more centimetres, and the



Only a few centimetres separated, on May 28th, the two edges of the deck.

The challenge met: smiles guaranteed.

immense steel ship arriving from the Larzac plateau, 1,700 metres to the south, comes to a final halt. Fifteen months after it began crawling forwards, it has reached its goal. It will not go much further. The three centimetres, which still separate the two halves of the deck, remind us that, after the

euphoria of this magic moment, a good number of tasks have still to be accomplished. "Now that the final connection has been completed, it turns out that the sections to be welded together are almost perfectly in line: no further cutting or adjustment is necessary.

The welding can therefore begin", explains Jean-Pierre Gerner. Once welded together, the joints will provide perfect cohesion to the entire structure. Simply a question of safety for the future users who will cross a structure guaranteed for 120 years! Nothing less. ■



90 metres more

The connection had hardly been completed when a strange steel giant made its appearance on the north side of the viaduct. Lying on its side, and transported by four self-propelled sixty-wheel trailers, pylon P1 was slowly brought directly above the concrete pillar where it would be tipped into a vertical position a few days later.

The transport of the pylon took place without a hitch. The operation was just delayed by a pause of a good half-hour, the time necessary for analysing the reactions of the deck subjected for the first time to a weight exceeding 700 tons. The conclusion was that no significant deformation was recorded. The same procedure will be repeated once a week

on the south side for the last four pylons. Towards August 20, 2004, the seven pylons will have been placed in position and secured with stay cables. The viaduct will then have taken on its definitive aspect. ■



700 tons at arms' length

In order to install the pylons permanently, two enormous steel arms (secured by stay cables to ensure their stability) will be temporarily erected on either side of each of them, and fixed to them slightly above their centre of gravity. These "levers" are equipped with two hydraulic systems each with a lifting capacity of 1,000 tons in order to raise the pylon gradually. During the lifting operation, the pylon will pivot little by little due to the laws of nature into a vertical position, immediately above its anchorage point. Everything will be under control, of course!



Press

Everything about the Millau viaduct

The Midi Libre has just published a special issue entirely devoted to the Millau viaduct.

In 112 pages, seven chapters (one per pillar!) and more than 200 photos, the history of this exceptional structure is

described, from the first earthworks to the junction of the deck. The publication is at the same time intended for all types of reader. It is educational, but also strictly accurate in the information it provides. It is on sale at all newsagents. ■



Eiffage in brief

- Eiffage will construct the sixth bridge over the river Seine at Rouen. Its two towers will allow a deck weighing 1,300 tons to be raised 56 metres above the river traffic.
- The creation of the "Cultural Village" begins in Brussels. A theatre, multi-purpose complexes, retail outlets and 80 residential units will surround

- a small square, constructed and partly financed by a Belgian subsidiary of Eiffage.
- A succession of tramways: after those of Valenciennes, Grenoble, Mulhouse and Clermont-Ferrand, Eiffage has just won the contract for three sections of the future tramway that will follow the route of the Maréchaux boulevards in Paris.

The project manager and the contracting authority: who does what?

The successful operation of the Millau construction site depends in part on the clear definition and respect of the respective roles of the contracting authority and the project manager. An exchange with Jean-Claude Mutel, director of the CEVM Compagnie Eiffage du Viaduc de Millau contracting authority and Jean-Claude Calcoen, SETEC TPI director of works

Who are the main participants on a construction site such as that of the viaduct?

Jean-Claude Mutel

As always on an important construction site, we created a classic organisation in which three categories of participants play a role: the contracting authority, the project manager and the companies carrying out the work. The role of the contracting authority, in this case the Compagnie Eiffage du Viaduc de Millau (CEVM), consists in

defining, financing and organising the construction, as well as managing and maintaining the structure. By definition, the contracting authority fulfils no technical roles, which are all under the responsibility of the project manager. The latter is in charge of checking the conformity of all the work carried out on the construction site (from the foundation slabs of the pillars to the restoration of the natural site) using the procedures and qualitative system previously defined. We chose as project manager SETEC TPI, an important engineering company independent of the Eiffage Group, and associated for this project with the SNCF French national railways.

Why the SNCF?

Jean-Claude Calcoen

Quite simply because it is the group owning the largest number of metal structures in France! Its mission is to supervise the manufacture of the steel panels in the different Eiffel factories, and to check the assembly of all the metal sections, with the assistance of specialised, independent consultancies.

Does the Eiffage Group not have the necessary skills to act as project manager?

Jean-Claude Mutel

That is not the problem. Since the contracting authority and most of the companies working on the site belong to Eiffage, it proved indispensable for the project manager to be independent of the group. The contrary would



Jean-Claude Calcoen, SETEC TPI director of works.



Jean-Claude Mutel, director of the CEVM contracting authority.

not have been desirable. Such projects in fact cannot be managed on a "monolithic" basis. SETEC TPI has to some degree, relatively speaking, the power to challenge the Group's authority.

What exactly is the role of SETEC TPI?

Jean-Claude Calcoen

To begin with, we completely reworked the theoretical calculations concerning the construction of the viaduct with our own computer programmes. These had first been produced by the research consultancy selected by Eiffage. We therefore made sure that they were accurate. It is also our responsibility to give the go-ahead for work to proceed at every new phase of the construction. This lifting of "work stoppages" depends on an examination of the techni-

cal controls carried out and the procedures in place. The complete sequence of procedures is systematically examined with a fine toothcomb in order to guarantee its quality. If a problem is revealed, we advise the contracting authority and call work to a halt immediately.

In the end, who has the final power of decision if there is a disagreement between you?

Jean-Claude Mutel

We have the last word. However, generally speaking, the fact that we are in permanent contact has always enabled us to resolve any problems that we have encountered. Nevertheless, to overcome

any eventual blockage, we have engaged a panel of international experts responsible for advising us in our decision-making.

Can you give us an example of the intervention of these experts?

Jean-Claude Calcoen

Yes, certainly. To guarantee a longer life span for the concrete subjected to the forces of traction experienced at the tops of the pillars, we wished prestressing cables to be installed in the final "needles" at the top of each one. This had not been planned for at the outset. When the college of experts validated our opinion, CEVM immediately conformed and had all the necessary work carried out. ■

The canopy takes shape



When completed, the canopy will be 98 metres long, 28 metres wide, and weigh 2,400 tons.

At the rate of two voussoirs placed in position every day, the canopy for the toll barrier, (98 metres long, 28 metres wide and weighing 2,400 tons), assumed its definitive shape at the end of June. "Once transported to the site with the help of a multi-axle trailer (Kamag), each element is taken over by a very powerful crane (500 tons)", explains Jean-Pierre Martin, director of the site. "Held between a C-shaped crosspiece, the voussoir is turned over with the help of hydraulic jacks (Strand Jacks) from its initial vertical position to a horizontal position. Having been realigned, it can be "presented" (with infinite precautions) opposite the last element already in place. The elements in contact with each other are then coated with glue, and the voussoir is secured to the previous one. A complete frame under the canopy enables this to be supported during the entire assembly phase. Since the geometry of the canopy is very complex, it requires to be meticulously monitored. For this reason, two computer assistants help the surveyor to control the positioning of the voussoirs". ■



Gunther, a high-precision driver

With the joystick between his hands, Gunther drives the enormous Kamag self-propelled trailer from the Sarens company with the precision of a watchmaker. Indeed, the passage for leaving the platform where the 53 voussoirs have been poured proves to be particularly tight: just a margin of a few centimetres for manoeuvring this 500-horsepower monster measuring a good twenty metres in length with no less than 120 wheels! No room for error: the seventy tons of the element for the canopy - constructed in BSI Ceracem, an ultra high-performance concrete - are resting delicately on the trailer. They must arrive without mishap six kilometres away at the toll barrier construction site. There is only one possible route for the journey lasting an hour: the A75 motorway under construction. At the slightest irregularity of the road surface, Gunther adjusts the hydraulic jacks mounted on each axle in order to keep the voussoir level. An assignment requiring total concentration every second.

Symposium

The professionals of the steel industry at Millau

The Technical Office for the Users of Steel (OTUA) welcomed experts on bridges and civil engineering structures from across the world for the Steelbridge 2004 Symposium. Questions put to Sylvie Pététin, president of OTUA.

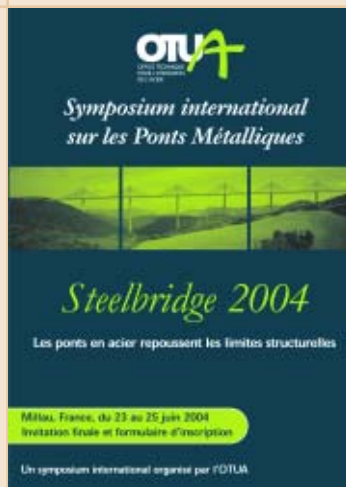
What subjects did you examine?

OTUA stimulates the exchange of information, federates the profession and publishes material on the specialist skills of recognised

experts in this field, particularly in France. International symposiums are the opportunity for everyone to take stock of the latest situation, and on this occasion to share experiences on an international scale. The innovative capacities of steel are immense, as can be seen in exceptional structures like the Millau viaduct. However, steel is also the material used for more everyday structures which, although not as spectacular as the Millau viaduct, are no less interesting. The exchange of views during this symposium were, in the participants' own words, extremely profitable.

Why did you choose Millau?

Millau imposed itself almost as a matter of course for the organisation of a symposium in 2004 on steel bridges, at a time when the international media on this subject is focussed on the Millau viaduct construction site. The only difficulty which we had to study carefully concerned the logistics.



Millau is a town with 23,000 inhabitants and a limited capacity for hospitality. With the help of everyone, first and foremost the services of the Millau town council, but also the DDE Departmental Economic Authority, the AIOA Interdepartmental Administrative Area for Civil Engineering Structures and the Compagnie Eiffage du Viaduc de Millau, OTUA was able to satisfy the conditions for holding the symposium on the spot, in a natural

landscape that the participants will certainly not forget.

How many participants did you receive?

We welcomed more than 300 specialists from throughout the world who are working on bridges: contracting authorities, project managers, designers, construction companies and suppliers. Twenty-six countries from four continents were represented. There were about forty specialists coming from Asia (Japan and Korea), about ten from North America, thirty from Spain etc. The French only represented 20% of the participants, so the symposium was truly international. The world's leading experts acknowledge the interest and importance of these events organised by OTUA. Paris welcomed 330 experts on footbridges for Footbridge 2002, while Millau welcomed just as many experts for Steelbridge 2004. The next Steelbridge 2006 could well be held in Italy. ■

Testimony

Developing a quality label



Doctor Pierre Raynal, chairman of Micropolis and vice-chairman of the Regional Council.

As a leading tourist destination, the Aveyron department has succeeded in its economic transformation. Nowadays, although the rural community represents a basis of the Aveyron economy, an industrial fabric generates numerous jobs in diverse and innovative sectors. "Take the case of Micropolis, the city of insects", explains Pierre Raynal. "In the four years it has existed, we have earned wide recognition to the extent that we are the most visited paying site in the Aveyron, together now with the Millau viaduct. The opening of the A75 motorway is a wonderful growth opportunity for us. But we have to ensure that we make good use of our current assets – the Millau viaduct, the Tam gorges, Roquefort... - to retain our visitors". To this end, the viaduct and the A75 motorway provide concrete answers to the needs of the department: the heart of the Aveyron will be a maximum of one and a half hour's drive from Montpellier and the Mediterranean beaches. The opening up of the region will provide a stimulus to existing business (in the fields of mechanical engineering, computers, agriculture and tourism) and will attract new activities. "To succeed, we shall have to respect certain basic rules: continue to preserve our countryside and our heritage, and develop a label of quality", concludes Pierre Raynal. ■

Transport

As chairman and managing director of Prat transports and vice-chairman of the Chamber of Commerce of Clermont-Ferrand Issoire (Puy-de-Dôme), Bernard Prat fully appreciates all the advantages which will be provided by the future opening of the Millau viaduct. Certainly, there will be a saving in time, but also

An economical route

financial benefits and an improvement in working conditions for the drivers of his 55 trucks. "The journey between Perpignan and Paris will no longer take more nine hours", he estimates. "This means that a driver will be able to make the journey in only one working day. The other routes, all of which take longer, require – in order to

respect legislation – an eight-hour break... or the presence of a second driver. Moreover, this new return journey on a weekly basis will generate a saving of 5,880 euros a year per truck as compared with the A9-A7-A6 motorway route. Moreover, this is only counting the motorway tolls. It is considerable! The charge

for crossing the viaduct will be easily covered by the savings in time, diesel fuel and material wear (brakes...). Moreover, it should be noted that the parking areas on the A75 motorway offer genuine rest areas. They allow our drivers to breathe some fresh air, with plenty of space to relax... while enjoying the superb countryside"! ■

Planning

Impatient for Christmas!

After the completion of the concrete pillars, the abutments and the deck that now spans the full width of the river Tam valley, it would be tempting to think that the construction site has been completed... or that at most there only remain a few details to settle. However, if drivers are to be able to cross the viaduct next December 18 at the time of the Christmas holidays, the quantity of different tasks remaining to be completed between now and then will leave no respite to the companies responsible for carrying them out. "Putting

the structure into service naturally presupposes that it is 100% complete", explains Jean-Pierre Mutel, managing director of the Compagnie Eiffage du Viaduc de Millau (CEVM). "This includes not only the viaduct itself, but also the toll barrier. Add to this the validation of the static and dynamic tests concerning the resistance of the viaduct, as well as the training of the operating staff. Today, only the spectacular part is finished"! All will have to be perfectly in place on the final day so that the first vehicle can pass through the toll barrier. ■

Catering

Good ideas along the A75

To the north and south of Millau, on the A75 motorway, numerous inns and various cafeterias allow the drivers of long-distance lorries or passenger vehicles to discover places with a friendly atmosphere in the heart of the countryside.

The drivers of passenger vehicles or long-distance lorries who have used it are unanimous: travelling south towards the Mediterranean on the A75 motorway is really worth the journey! With its spectacularly beautiful wild landscape and its numerous mid-altitude mountain passes, this motorway has nothing in common with other main trunk roads that follow a straight line across plains and valleys! However, just following the asphalt ribbon without trying to discover the side roads would mean denying oneself part of the charm of the journey. There is a series of good addresses all along the way. Long-distance lorry

drivers on the look out for welcoming spots for the time of taking a break will find what they are looking for just a few hundred metres from the motorway. Just next to exit 41 north of Millau, the Bon Secours restaurant is one of the places where the professionals of the road get together. Here, drivers have settled for generations. "This house was built at the end of the eighteenth century", explains Thérèse Vayssié, the owner of the spot. "It is an old coaching inn, and my family has always lived here. Nowadays, we have our regular visitors. Heavy goods vehicles come here from all over France, but also from Holland and Spain". A little further on, south of Millau, the Larzac rest area cafeteria also welcomes visitors, just like the Caylar cafeteria situated right under a rocky outcrop dominated by a statue of the Virgin Mary. There is no concentration camp type of car-park here! Drivers can get together in the peaceful atmosphere before swinging on down to Montpellier, Béziers or the south of Europe via the breathtaking Escalette pass. There is no doubt that other good addresses will be revealed between Clermont-Ferrand and Béziers. ■

Provisional agenda

- **August 20**
Raising of the last pylon.
- **September 15**
Initial stressing of the stay cables.
- **September 30**
Completion of the waterproofing of the deck and the application – in a single coat - of the surfacing (60 centimetres thick). Beforehand, the steel will be sandblasted down to the raw metal in order to eliminate any impurity that might detract from its resistance over the long term.
- **October 2**
Completion of the installation of the safety equipment.
- **October 30**
Final adjustment of the stay cables.
- **November**
Dynamic and static tests of the

- structure. An armada of lorries weighing in all 1,000 tons will be positioned in different configurations on the viaduct.
- **From early November to mid-December:**
Training of the operating staff.
- **As from November 15:**
Start of the first campaign for winter servicing. Lorries, scrapers, salt, brine preparation units, and diverse procedures will have to be operational by then.
- **December 18:**
Opening of the viaduct to traffic. The installation and testing of the different networks (electricity, computers, instrumentation, and telephones) will be carried out at the same time as the phases mentioned above.



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