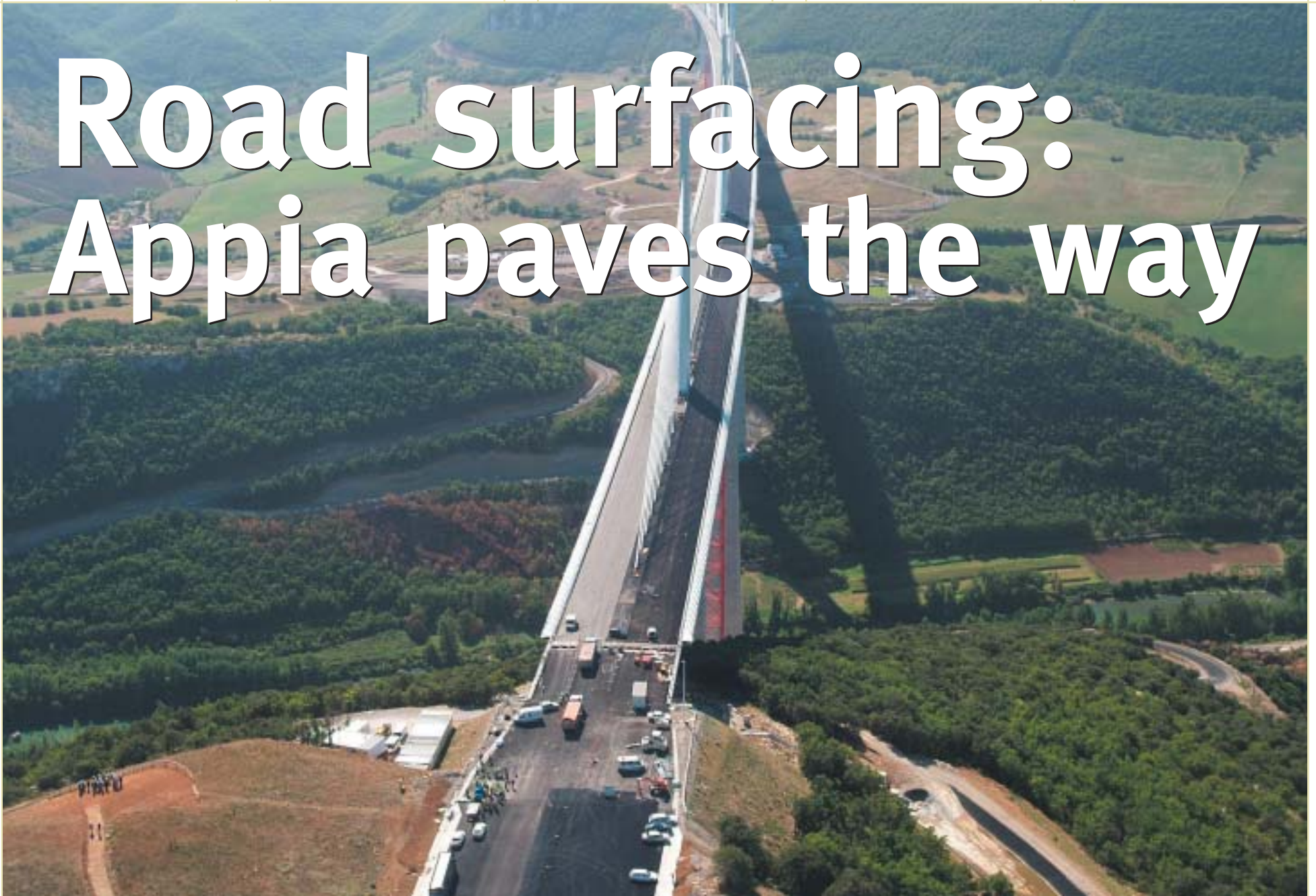


# viaduc

ÉDITÉ PAR LA COMPAGNIE EIFFAGE DU VIADUC DE MILLAU

## Road surfacing: Appia paves the way



**The Appia teams only needed three full working days to lay the road surfacing on the Millau viaduct. Carried out in record time, this operation transformed the steel deck into a motorway which will soon be ready to welcome cars and lorries. A flashback!**

Slowly, but without ever stopping, the “Titans” move forward across the viaduct. Permanently enveloped in a cloud of steam which only the gusts of wind dissipate for a few seconds, they are laying the road. “Titans”? This is the name of the two enormous machines – “finishers” in the language of bitumen professionals – indispensable for laying the 10,000 tons of surfacing on what will become the viaduct roadway. Up in front is an immense hopper, fed constantly by an armada of lor-

ries: each articulated lorry is replaced by the next, because here the work is a continuous flow. There is no question of risking the slightest break in the supply to the finishers. Behind these, a worm screw lays the precise quantity of road surfacing material necessary onto the deck. After these machines have passed, the viaduct will never be the same again! A long black ribbon, seven centimetres thick, covers the steel. Smooth and without a wrinkle. Just like a billiard table which

Appia, through its subsidiary Mazza, is preparing for drivers who, in a few weeks’ time, will cross the highest bridge in the world.

### There and back across the viaduct

“Everything’s going well! When we get to P7, we break off at P1 and start again!” It is just after four o’clock in the afternoon of September 22, 2004, and the mobile work site is approaching the south side of the viaduct. Satisfaction

can be read on the face of Marc Courtehoux, the Appia works director. Having set out at dawn from the other side of the valley, more than two kilometres to the north, the laying of the road surface on the western half of the viaduct is nearing completion. A second crossing (on the eastern side) will enable the task to be finished. Another full day’s work in sight for the team of about 90 operatives involved.

Everything was foreseen so that nothing could disturb the smooth flow of the work in progress. “We set up two road surfacing production units some ten kilometres to the north of the viaduct”, stresses Marc Courtehoux. “Their overall capacity is close to 380 tons an hour. If one of them were to break

down, the second unit would be sufficient to maintain the output necessary for work to continue. The raw materials were delivered to us a few days before work began: the pebbles come from the Arviu quarry in the Aveyron department, and the bitumen from our Corbas production facility close to Lyon”. From the logistical point of view, twenty-five articulated lorries plied constantly between the production site and the viaduct.

### Twenty minutes for compacting

On the deck, the two finishers are working side by side, covering a total width of 11.20 metres. A few dozen centimetres in the lead, the smaller of the two (3 metres wide) is responsible for laying the tarmac on the hard shoulder. The second (8.20 metres wide) lays the surface for the two traffic lanes. This is a quite theoretical distinction, since the layers spread by the two machines are perfectly matched. No joint is visible. The driving comfort of the future clients of the viaduct must be paramount! “The thickness of the road surfacing laid on the deck during the spreading, before being compacted, is 8.2 centimetres”, points out Marc

Continued on page 2

## Christmas Holidays 2004 : opening of the viaduct

Representing a true alternative to the Rhone valley route, the Millau viaduct and the 40 additional kilometres of the A75 motorway will open to traffic for the Christmas holidays. Of vital importance to the region, the viaduct will “explode” the infamous Millau bottleneck, thereby allowing a saving in time of thirty minutes under normal circumstances and up to four hours on certain weekends in the summer for crossing the gorges of the river Tarn. Of true national and international significance, the viaduct will allow transport companies to make considerable reductions in the journey times of their heavy goods vehicles: 45 minutes between

Paris-Perpignan, Paris-Barcelona or Amsterdam-Perpignan. The Rhone valley route being frequently close to saturation, these savings in time, calculated for normal traffic conditions, could be appreciably greater, especially when the traffic is heavily congested to cross Lyon. This new itinerary will moreover allow a saving of as much as € 34 per journey in motorway tolls, not to mention the economies in fuel made possible by a route which is 60 kilometres shorter. Before the first vehicles arrive, an inauguration ceremony has been planned in mid-December, exactly three years to the day after the first stone was laid! ■

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Marc Courtehoux, works manager for Appia.

Courtehoux. "After the compactors have passed, the driving surface will not be more than 7 centimetres thick". The compacting phase represents a vital moment in the creation of the roadway. Once laid at a temperature of 170 degrees centigrade, the road surfacing material cools rapidly. Below 140 degrees centigrade, it is almost no longer possible to compact it. This means that the teams responsible for this operation have only twenty minutes to act. Immediately, therefore, two double-cylinder compactors (each with a capacity of 9 tons) go into action. They in turn are followed by smaller machines with the task of smoothing out any marks which the first machines might leave. For the road surfacing just as for the rest of the construction, there is no question of tolerating the slightest imperfection. ■

\* 9,000 tons for the traffic lanes and the hard shoulder, and 1,000 tons for the central dividing section between the two roadways.



Cleaning the deck surface, and ensuring the grip of the road surface : two aims of the shot blasting.

### Pebble blasting

# What is hidden under the road

The role played by Appia is not limited to the road surfacing. A certain number of preliminary stages were necessary for this operation, which only represents the visible part of the iceberg, to be carried out satisfactorily! "Our role consists in laying a road on an existing surface", explains Marc

Courtehoux. "But this surface – in this case steel – presents characteristics which have to be mastered perfectly: it becomes oxidised and it is slippery! We therefore had to find solutions for waterproofing the surface and to enable the coating to adhere to it perfectly". First step: pebble blasting. To what end? To

eliminate the slightest trace of oxidation and to roughen the surface of the deck. To do so, steel ball bearings, a millimetre in diameter, were blasted under high pressure over the entire surface of the deck. More than 150 tons of ball bearings were used to carry out this operation. Once this stage had been com-

pleted, a primary coat was applied to the raw steel and a four-millimetre-thick bituminous sheet was hot welded at 400 degrees centigrade to the 65,000 m<sup>2</sup> of the deck. Perfect protection against oxidation... and a specially designed surface to receive the coating in all security. ■



### Three questions for...

## Daniel Calinaud, chairman of Appia



**Appia was selected to lay the surfacing on the Millau viaduct. How did you respond to this challenge?**

The development of a specific surfacing proved to be a real test for all the teams at our research laboratory at Corbas, near Lyon. This enabled us to demonstrate our innovative capacity when faced with an exceptional situation. Two years of studies and tests were necessary to determine the ideal formula for the viaduct's bitumen and to check its durability. In January 2004, the conformity specifications were submitted to Setra. When the surfacing was laid at the end of September, everything was in place so that the operation could be carried out in the best possible conditions.

**How was your co-operation with the other companies of the Eiffage group already present on the viaduct?**

The work we did at Millau enabled us to develop true synergies with Eiffel, Eiffage TP, Forclum, etc. I would underline the fact that this is the first time we have collaborated so extensively to lay tarmac on steel. Our technical services worked together perfectly, a fact which enabled us to reach the clearest possible understanding of how the two materials interact.

**The laying of the road surface was covered by all the media. What does such an exposed work site represent for you?**

The Millau viaduct is without question an exceptional showcase for Appia. It placed our company at centre stage to an extent it had never experienced before. It highlights our expertise, and demonstrates the overall success of the Eiffage group. ■

## A family affair

Appia, the road construction branch of the Eiffage Group, itself called on its various subsidiaries to make a success of laying the coating on the Millau viaduct. AER (Appia Road Equipment) was responsible for the pebble blasting of the deck and the construction and installation of both the reinforced

concrete and metal crash barriers. The "Transports du 45e parallèle" company undertook to convey the coating between the production site and the viaduct. Mazza carried out the laying of the road surfacing. Only the bituminous sheeting was developed and welded by Siplast and Sacan respectively. ■

## A few definitions

● The coating material is composed of several types of solids (pebbles, gravel and sand) bound together by bitumen. It constitutes the top layer of several sub-strata (bed, foundation, etc.) and it is on

this surface that the traffic flows.

● Bitumen compounds are on the other hand mixtures of hydrocarbons and their sulphurous, nitrogenous and oxygenated by-pro-

ducts. They are often associated – incorrectly – with asphalt preparations, which are in fact bitumen compounds mixed with solid materials (sands or pulverulent rocks). ■

# A specific surfacing extensively tested !

At first sight, nothing distinguishes the Millau viaduct coating from an ordinary motorway surfacing. Nevertheless, the Appia research teams needed no less than two years work to develop a high technology product capable of meeting the constraints set by the structure.

Laying a coating on a metal surface bears no relation to carrying out the same work for a normal roadway. Indeed, the deck's steel is subject to multiple deformations to which the road surfacing must necessarily adapt itself. Apart from expansion, the main constraint which the coating experiences is located at the position of the longitudinal reinforcements placed under the steel plates. The difference in the degree of expansion

due to the constant passage of vehicles immediately above the welding of the reinforcements to the plates would provoke cracks in the tarmac. Such deterioration would rapidly provoke the road surfacing to separate from the deck, causing it to lose its waterproof properties. Unthinkable on the Millau viaduct! For almost two years, the teams of the Appia research laboratory situated in Corbas (Rhône) there-



fore worked flat out in search of the ideal bitumen formula capable of solving this problem. Without neglecting the other criteria for a motorway bitumen worthy of the name (density, texture, adhesion, etc.). "We tested about fifteen

bitumen formulae before developing the bitumen which corresponded exactly to our requirements", explains Bernard Héritier, the Appia technical director. "We chose materials known for their ability to resist rutting. We added components (polymers) to each of them corresponding to the rubbery consistency we wished the bitumen to have. We were searching for a formula which would be flexible enough to absorb the deformations of the steel, yet resilient enough to retain its initial properties".



Bernard Héritier, directeur technique d'Appia.

10 degrees centigrade! A week of non-stop torture carried out under perfectly controlled conditions to respect the guidelines of conformity set by Setra for this type of material.

"At the same time as we were carrying out these simulations, the Ponts et Chaussées laboratory ran a series of cross-sectional tests", adds Bernard Héritier. "We wanted to be sure that there were no flaws in the different layers between the steel, the waterproof sheet and the bituminous surfacing". During the spring of 2004, a test was run at Rivesaltes (Pyrénées-Orientales) on a replica of a cross girder section provided by Eiffage. At the end of July, a full scale trial of laying the tarmac was conducted on the deck itself. All these were indispensable stages to make sure that vehicles can cross the viaduct in a maximum of comfort. ■



11 pairs of stays fasten on each pylon.

## Freyssinet installed the stay cables...

Freyssinet achieved a truly amazing feat in only three months: securing the stay cables to the seven pylons of the viaduct. By the end of August, the structure had adopted its definitive configuration for everyone to see.

A sprint. Jean-Luc Bringer, site director for Freyssinet, makes this quite clear. "Attaching the 130\* stay cables was carried out in an extremely short time. Indeed, the work was completed in only twelve weeks. We started on June 16th, and completed everything by the end of August". At least almost everything! A few less visible tasks still remain to be carried out between now and the opening of the viaduct: the final adjustment of the tension of the stay cables, installation of the anti-vibration shock absorbers, the positioning of the waterproof caps at the fixation points, etc. A work of precision which calls upon the skills of a task force of close to one hundred people. Each stay cable is made up of a polyethylene sheath containing

between 55 and 91 steel cables (strands) depending on the overall length of the stay cable. The strands are themselves each made up of 7 steel wires, a central wire with six wires twisted around it. The stay cables are erected simultaneously opposite each other, pylon by pylon, following a perfectly tested technique. "A master strand is inserted into the sheath while it is still on the ground", explains Jean-Luc Bringer. "The sheath is then hoisted up the pylon with the help of a winch until it reaches its definitive position. The strand is then inserted into its upper and lower anchorage points, and then placed under tension. A "shuttle" enables the other strands to be brought one by one into position. Specific equipment is then used to subject them all to a strictly identical

tension". In total, more than 900 tons for the longest stay cables: enough to support at least twenty articulated lorries!

The Millau viaduct benefits from all the latest technology developed by Freyssinet. Every strand is protected against corrosion by a triple protection: after galvanisation and coating in petroleum wax, they are moulded in extruded polyethylene. The external sheath (inert to ultraviolet rays) possesses, for its part, a double spiral the full length of its surface. Its purpose is to prevent any water from running along the stay cable which otherwise, by altering its profile, could cause oscillations, under strong winds, of more than a metre, thereby even affecting the stability of the viaduct itself. As regards maintenance, six stay cables have been equipped with instruments. Accelerometers and acoustic probes will enable their condition to be monitored. A permanent check-up guaranteeing they will remain in perfect condition for the next 120 years! ■

\* 24 stay cables had been previously erected on pylons P2 and P3 to guarantee that the launching phases of the deck were carried out successfully.

## Anchors to secure the viaduct

Freyssinet's role was not restricted to attaching the stay cables. The company was also charged with anchoring (or pinning) the deck to the piles. At the top of each of them, 16 cables each made up of 37 strands secure the steel to the concrete. They are true "anchors" which guarantee the stability of the structure throughout the full period of its operation. ■

## The viaduct's new visual identity

As soon as the viaduct is opened to the public, all public relations activities aimed at making the advantages of the viaduct known to European users will focus on the twin identity: The Millau Viaduct – Eiffage, the image of each serving to promote the other. All visual representations will reflect this new identity: logo, stationery, vehicles, uniforms... ■



## Highlighting the structure

Foerclum and its Aveyron subsidiary Guirande installed the architectural lighting of the viaduct designed by the architect Norman Foster. A subtle play of light and shadow which merges as intended discretely into the nocturnal surroundings.

## Eiffage at a glance

• Through its subsidiary responsible for public car park concessions, and its new acquisition Epolis, Eiffage becomes the second largest car park operator in France. ■

## Security

# The viaduct in all serenity

The tourists visiting the Cazalous viewing area ask quantities of questions about traffic conditions on the viaduct. Answers from Jean-Claude Mutel, director of the Compagnie Eiffage du Viaduc de Millau.

### Are people likely to suffer from vertigo when they travel across the viaduct?

Not at all! The viaduct is just like a 2x2 lane motorway completed by a 3-metre-wide hard shoulder. This is lined by a crash barrier with an outer cornice 2.15 metres wide surmounted in turn by windbreak screens. A driver can therefore only have a horizontal view of the panorama... but no view down into the valley.

### What happens in the case of a breakdown?

The system in place is identical to that of an ordinary motorway. You just have to park on the hard shoulder and call for help at one of the emergency telephones placed every 500 metres. Besides, video cameras which automatically detect every incident enable us to locate anything unusual on the roadway. The surveillance centre positioned next to the toll barrier will then be immediately alerted. In a few minutes, the motorway patrol will be on the scene of the accident.

### At what speed can one drive on the viaduct?

The viaduct possesses this configuration of a "normal" motorway. The authorised speed will therefore be 130 kilometres per hour for cars. Lorries will be subject to the usual motorway restrictions.

### What precautions should be taken in the case of high winds?

Three-metre-high screens running the entire length of the structure



Steel crash barriers and windbreaker screens for a maximum safety

cut the wind speed by 50%. There will therefore be less wind on the viaduct roadway than on the surrounding Causses. In other words, in the case of blustery weather crossing the viaduct will present no problem! It should be noted however that the structure is guaranteed against winds of 245 kilometres per hour. Something never encountered in the region.

### What should be done in the case of an accident?

A specific rescue procedure approved by the prefecture has been established. It covers not

only the means of intervention but also their organisation. From the motorists' point of view, information panels have been set up and a system for closing the viaduct can be activated.

### Have you planned for freezing weather?

Of course! Meteorological stations are in place on the viaduct and temperature sensors are imbedded in the roadway. We also have at our disposal all the infrastructure necessary to salt the viaduct and to ensure its winter viability. ■

## Testimony

# "A monument on my commune!"

Meeting with Pierre Garlenc, mayor of Creissels.

The viaduct has now become a reality. Does it represent an opportunity for your commune? Absolutely! It is a true chance for Creissels. This national and international technological showcase will undoubtedly strengthen the tourist attraction to the South Aveyron and to our village in particular. In the mid term, we are going to take every possible step to profit from the boost this unique structure has brought us linking the Causse rouge to the Larzac plateau.



### Does the construction of the viaduct bring with it economic growth for the commune?

The revision of the local urbanisation plan (PLU) will lead to the development, at the western approach to the Millau built-up area, of the Cazalous visitors' centre and an urban development zone (ZAC). These two projects will be carried out in collaboration with the Community of the Millau-Grands Causses communes which possesses the necessary expertise for everything concerning the development of the economy and tourism. They should give Creissels a dimension which the commune could never have attained without the construction of this structure.

### Have you already noticed any positive repercussions on the lives of the Creissels' inhabitants?

Local businesses are already profiting from the "viaduct effect". Three restaurants and two hotels have seen their business grow very considerably. A hypermarket has just opened at the bottom of the incline leading to the foot of the viaduct. Finally a car dealer and a pottery have opened recently in our area.

### An increase in tourists brings with it an increase in traffic. How do you intend to handle this traffic surplus on your commune?

The departmental road 992 which crosses Creissels will undergo some slight modifications. Indeed, these will lead to the creation of two lanes of uphill traffic with a single downhill lane between the centre of the village and the viaduct with the financial assistance of the department. This will improve the safety of the roadside inhabitants.

### As mayor, but also as a citizen and native of Creissels, what is your personal impression of the viaduct?

First of all as mayor, I am particularly proud that such a monumental structure has been constructed on my commune and to have participated myself in a number of meetings concerning the construction.

I would never have imagined that more than 400,000 visitors would cross the village over a period of a few months! As a citizen, I am filled with admiration for the work carried out by the work force, the precision of their gestures... and the great kindness of their directors"! ■

## Soon the 500,000th visitor to the Cazalous

● Will the symbolic number of half a million visitors be reached before the inauguration of the viaduct next December? The question is quite realistic. Indeed, by the end of the summer, more than 400,000 tourists had already made the detour to the Cazalous viewing area since work started on the construction site. Every day, coaches and cars flow unceasingly past the foot of the viaduct which has become, in a few months, one of the main tourist attractions of the department.

● Several official delegations visited the construction site during the summer. Of particular note, among others, was the visit of François Loos, Minister of Overseas Trade and that of the members of the Constitutional Council under the leadership of its president, Pierre Mazaud. Also of note was the visit of a delegation from Senegal, directed by Mamadou Seck, Minister for Infrastructures. ■



## Souvenirs, souvenirs...

Visitors had been asking for it with insistence at the Cazalous viewing area... here it is at last! The viaduct shop was opened last July 21 at the centre of the welcome pavilion. DVD, postcards, posters, watches, T-shirts with the viaduct logo are now on sale. A full range of souvenirs to choose from, to remember a moment filled with emotion. ■



Creissels : one of the two communes to welcome the viaduct.



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