World-record-breaking 343m-high

The highway bridge currently being constructed over the Tarn River in Southern France will be 19 meters higher than the Eiffel Tower. At the time of publication of this Reporter issue, the highest of a total of seven bridge piers will have reached a height of 244m – merely 70% of its full height of 343m together with its steel pylon. The deck of this world's tallest bridge, which is under construction one hundred kilometers north of Montpellier, will span the Tarn River valley at a height of 270m.

The bridge and the towers bear the aesthetic hallmark of the famous architect Lord Norman Foster and bridge construction engineer Michel Virlogeux. Another top name in civil engineering, responsible for the construction of the 2460m-long and 343m-high bridge is Eiffage TP and Eiffel. These civil engineering specialists were famous for their top-notch engineering feats even prior to erecting the Eiffel Tower for the World's Fair in Paris in 1889. As for most of the great engineering feats of the world, all of the construction measurements and controls are carried out using surveying systems from Leica Geosystems.

The "Viaduc de Millau", near the small town of Millau, will shorten the distance between Clermont-Ferrant and Montpellier/Béziers by one hundred kilometers. It will eliminate the current traffic problems on the highway section, which in the peak travel season can stretch as long as 50km and involve up to four hours waiting time.

Bridge production taking place at nine major sites

The completed construction project will not only be the highest bridge in the world, but its seven piers also make "Viaduc de Millau" the world's longest cable-stayed bridge with several central suspension pylons. However, a lot of hard work must still be done before the historic moment in January 2005, when the bridge is opened for traffic. Each of the seven bridge piers has its own major construction site, together with two 12-person teams working two shifts. Added to that are the two construction sites on either side of the sloped valley for the lateral ramps, with welding teams for the deck's steel sections. Two produc-

Automated Leica TCA2003 and TC1103 total stations are used to continuously monitor the progress of construction. Cast into the concrete piers are small, optical precision reflectors used to monitor the construction work also after its completion.

bridge

tion mills were built in the middle of the valley, one for steel fittings and one for concrete, as well as office trailers for the site management. The elements for the steel roadway profile plates are being produced and assembled in Eiffel's Lauterbourg and Fos plants and welded together directly at the two ramp construction sites. The nine large construction sites are being coordinated by the overall site management for "Compagnie Eiffage du Viaduc de Millau", and the surveying is directed by Pierre Nottin of Service Topographique Eiffage TP.

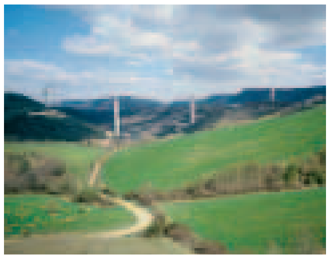
> "Precision and reliability of Leica GPS and TPS at highest-possible level!"
>
> Pierre Nottin

Surveying pioneers for top performance in constructional engineering

As is common on construction sites, the surveying engineer was the first expert on the grasslands scene, arriving in the Tarn Valley back in August 2001. Pierre Nottin from Eiffage TP essentially established the front line of over 400 specialists employed at the construction site. Besides the five-member surveying team, they are mostly made up of metal and engineering experts and concrete teams. According to the instructions and drawings of the civil engineers and the architect, Pierre Nottin established a local observation grid to determine coordinates in the GPS global positioning system WGS84 as well as for simultaneous contact-free measurements using terrestrial surveying instruments. A Leica GPS 530 RTK reference station was installed in a surveying pier anchored in the natural rock of the mountain slope and integrated into the local coordinate network. Using mobile Leica GPS 530 systems, the coordinates of the pier foundations were then determined, and all subsequent steps in the construction experts' work process tracked and calibrated. The main task of the five surveying specialists during the initial two years has been to determine the formwork positions with various cross-sections of the entire four meters of the slipform's height. The raising and fitting of the formworks must be determined with the utmost precision and continuously monitored at a total of 256 levels.

Built-in precision reflectors

According to the individual form of the pier cross-sections, which taper upwards and diverge from each other once they have reached a certain height, the



The Millau highway viaduct rests on seven piers of differing heights with a lateral distance between them of 343m. In the small picture from April 2003, the highest pier (second from left) had reached half of its full height. The large illustration is an artistic view of the finalised viaduct, where this pier will stand 343m tall, dwarfing the Eiffel Tower by 19m. This bridge represents the most important section of the A75 highway from Clermont-Ferrant in the north (running to the left) to Béziers/ Montpellier in the south.

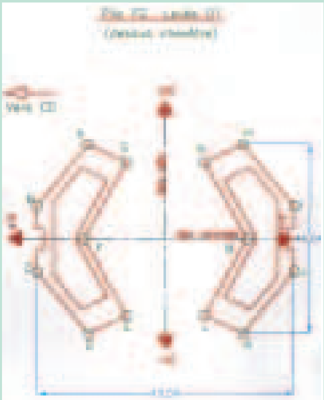
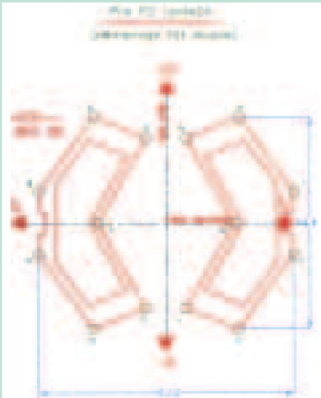
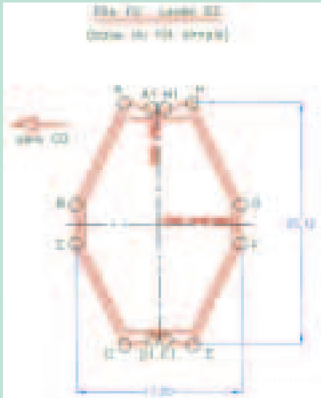
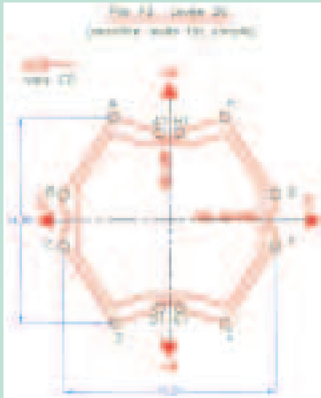
Chief surveyor Pierre Nottin was the first expert on the grasslands scene, arriving in the Tarn Valley back in August 2001. Here he points to the point of beginning.

To monitor the construction project, twelve conjointly secured fixed reference-point piers were installed along the bridge axis at well-accessible points, allowing survey measurements using forced-centering Leica total stations and reflector prisms as well as GPS antennae.

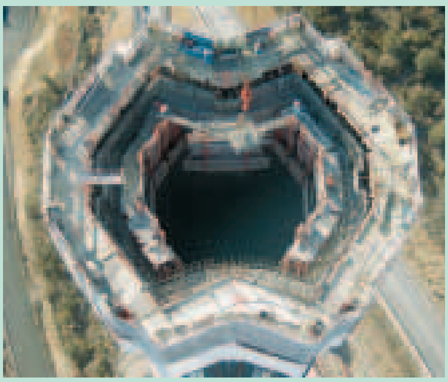
Filigree cement-steel construction weighs in at a massive 242,000 tons

Compared with the 324m-tall Eiffel Tower with its 7,500-ton steel structure, 36,000 tons of steel and 206,000 tons of concrete will be needed for this 343m-high and 2.5km-long, world-record-breaking engineering construction. All in all, seven piers of differing heights will be erected for the "Viaduc de Millau". With a distance of 343m between them, their eastward alignment forms a slight curve and causes a continuous north-south downward deck gradient of three percent. The uppermost 90m of the concrete piers are divided in two, with the appearance of a tuning fork. That means that the lowest pier (P1), which is 77m in height and built directly into the northern slope edge, was encased straight from the base in this basic split-filigree form.

The highest pier (P2) begins at the foot of a foundation that is 16m deep, has an area of 200m² and is anchored in the natural rock. It tapers increasingly towards the top to a height of 165m where it forks upwards from a further 90m. At the upper end, the pier's bearing area still has a cross section of 30m². The precast steel roadway profile plates will be connected to this uniquely designed bearing area using a special system. An 87m-high steel pylon is affixed in the center of each concrete pier, to which 22 steel stay cables are fastened. These lead to the strong center support of the steel roadway profile plates and transfer the force from the piers to the construction as a whole. A total of fourteen 171m-long and two 204m-long trapezoidal steel roadway profile plates, each 32.05m wide and 4.20m high, are being joined together on the lateral ramps, maneuvered towards the middle of the bridge by hydraulic presses, connected to the piers and anchored to the seven steel pylons with a total of 154 steel stay cables. The 32.05m-wide roadway profile plates offer enough room for two, two-lane decks of opposing traffic with emergency shoulders, a reinforced, load-supporting center section and three-meter-high protective sidewall wind barriers.

Like all bridge piers at Millau also the highest in the world (P2) is characterised by different sections. All positions are being defined from the basements on by the surveying team with Leica GPS530 rovers and monitored permanently. At P2 from a pier height of 165m, the profile forks upwards for a further 90m, before the 87m high steel tower is fastened to the roadway plates with the 22 stay cables. This pier will extend 343m up into the sky. In the right-hand picture the first steel roadway profile plate is pushed towards pylon P7. The Leica GPS 530 RTK reference station showed on the right-hand picture below, has been permanently installed prior to the start of the construction work, and transmits correction data 24 hours a day for the differential measurement of the entire construction site.



self-climbing form had to be continuously adapted to the horizontal angles and gradients each time another four meters of pier concrete are poured, as well as having to be precisely positioned to within just a few millimeters. It took three working days to concrete a four-meter-high form feed, meaning that a pier could "grow" as much as eight meters each week.

To monitor the construction project, twelve conjointly secured fixed reference-point piers were installed along the bridge axis at well-accessible points, allowing survey measurements using forced-centering Leica total stations and reflector prisms as well as GPS antennae. During construction, 150 survey reflector prisms have been cast into the outer encasement of the concrete piers and fixed in natural rock. Additional precision reflectors will be fixed on other important structural elements of the bridge. These can be automatically targeted and monitored with a high level of precision from the fixed reference points. The slightest of changes in the bridge piers – such as those due to temperature fluctuations and stresses – can thus be recognized immediately, benefiting not only the construction surveying team, but also the independently contracted geometrician M. Morin. Taking in consideration the engineering challenges of these bridge, the most precise instruments on the global market are being deployed in construction and monitoring. Pierre Nottin's surveying team relies on the precision total stations Leica TCA 2003 and Leica TC 1103 in addition to its Leica GPS 500 system, whereas certified geometrician expert M. Morin uses a Leica TDA 5005 industrial total station to determine his coordinates in conducting his control surveys, ensuring accuracy to within 0.3 millimeters. Numerous digital levels from Leica Geosystems are also being used. Surveying chief Pierre Nottin has everything securely under control: "What I've learned from many years of engineering surveying with classical terrestrial instruments is proving to be the case here, too. The precision and reliability of the GPS and TPS systems from Leica Geosystems are helping us to fulfil complex surveying tasks at the highest-possible level on the Viaduc de Millau as well. The consulting and service provided by Leica regional sales engineer Olivier Truttmann, as well as the Leica Geosystems office in Toulouse leave nothing at all to be desired."

> "Consulting and service provided by Leica Geosystems leave nothing at all to be desired."
>
> Pierre Nottin

Privately financed by the Eiffage Group

The 400-million-euro "Viaduc de Millau" is being privately financed by the Eiffage Group. Belonging to France's fifth-largest construction group with a turnover of seven billion Euro, are the biggest French metal construction and engineering firm Eiffel, the general contractor Eiffage Construction and its subsidiary Eiffage TP as well as the "Compagnie Eiffage du Viaduc de Millau", founded just for this project. Whoever compares the 120-year guarantee of the Millau viaduct with the life of the Eiffel Tower – constructed by company founder Gustave Eiffel in 1889 – has no doubt that this civil engineering work will also serve generations to come. The "Compagnie Eiffage du Viaduc de Millau" was awarded usage rights for 75 years, at which point the Millau viaduct will be transferred to state ownership. More information: www.viaducdemillaueiffage.com.

120-year bridge guarantee

The "Viaduc de Millau" is a technical masterpiece of the highest order and a hallmark of state-of-the-art technology. Its functionality is guaranteed for 120 years by the French Eiffage Group. In total three hundred small, precision optical reflectors will be embedded into the concrete encasement and will be fixed in the natural rock and on other elements of the bridge structure over the three-and-a-quarter year construction period. These durable and eternal gold-coated "diamonds" will help register even the slightest oscillations in this masterful structure of the "Viaduc de Millau" and will provide security for generations.

Stfi