Leica Geosystems TruStory

Real Time Bridge Deck Guidance Using GNSS Systems (Spain)

- **Company**
  Dragados S.A. Spain
- **Challenge**
  Real Time monitoring and guiding of a moving structure (motorway bridge)
- **Date**
  March 2008
- **Location**

- **Project Summary**
  Instruments
  6 Leica GX1230 GG Receivers
  6 Leica AX1202 GG Antennas
  Software
  Leica GNSS Spider
  Leica GeoMoS
  Leica Alignment Monitoring
  Communications
  Radio, GPRS, UMTS, Wi-Fi
- **Benefits**
  - Real Time 3D Monitoring of the structure
  - Displacements Calculations compared to 3D alignments
  - Continous hydraulic pushing manouvre thanks to the real time monitoring and GeoMoS alarms
  - Database storage of all measurements
  - Instant and continuous operation reports with Leica Alignment Monitoring
  - Easy Monitoring system configuration and installation and User friendly software

Arbizelay´s bridge, 380 meters long, 6 spans high, 5 pylons and 12 meters wide is part of the AP-1 Vitoria - San Sebastián Motorway and is located near the city of Mondragon. Thanks to Leica GNSS technology, it was possible to successfully complete the manoeuvre of incremental launching of the bridge´s deck over the pylons with an error of less than 3 centimetres.

Using 6 GX1230 GG receivers (5 rovers placed over the deck with 1 reference on a concrete pillar), the whole deck structure can be monitored in real time while the manoeuvre takes place.

Communication between GNSS receivers and Leica GNSS Spider software was established using 406 Mhz Satel radios. Other types of communications (GPRS, Wi-Fi) were tested and finally discarded due to frequency inhibitors and poor GSM coverage.

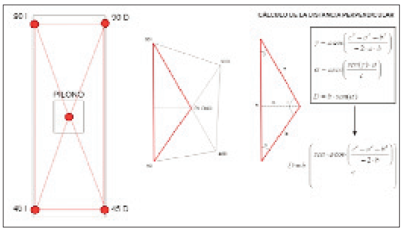
Both bridge´s decks (one from each side of the valley) were built on site by pouring concrete over a steel structure. Once the structure was ready, it was pushed over the pylons with the method of incremental launching of the deck with the help of hydraulic jacks (incremental launching cycles were 3 meters). In addition to the jacks, the hydraulic system relied on a pair of cables that were able to completely retain the bridge´s deck in case of emergency.

An auxiliary pylon was built in the centre of each deck with the task of holding steel cables, which were responsible for both the rise and fall of the deck´s nose (when the manoeuvre takes place, the nose slightly rises in order not to hit the pylons in its path; when completed, it lowers and rests on the pylons).

The whole GNSS monitoring systems was quickly and easily installed three times on both bridges' decks. Not only was the deck´s real time position monitored, but the central pylon's inclination as well.

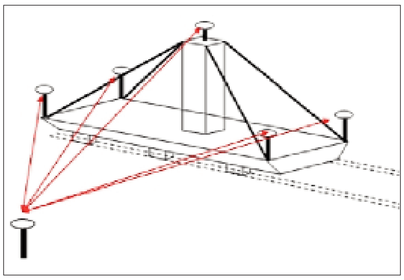
The project´s control centre was located in a nearby hut where a computer running Leica GNSS Spider received the data from the 6 GNSS receivers and calculated all 5 base-lines in real time. Real Time position of each of the rover GNSS receivers placed on the structure were sent at 1 Hz via TCP/IP to Leica GeoMoS and Leica Alignment Monitoring software in NMEA format.

Leica GeoMoS´s task was to make real time calculations of the central pylon's attitude (in particular its longitudinal and transversal inclination) as well as triggering different alarms if the project´s tolerances were exceeded. Inclination calculations are made possible thanks to the new GeoMoS 'Virtual Sensor' functionality.

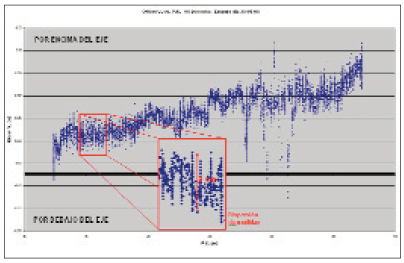


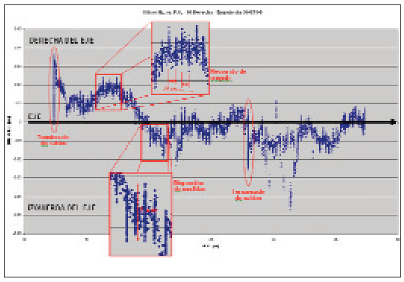
With the Leica Alignment Monitoring software, the positions, at 1 Hz, of the 5 rover GNSS receivers was compared with respect to the 5 theoretical trajectories of those points.. All these measurements were recorded on the MSQL Database and displayed using GeoMoS´ module 'Analyzer', thus obtaining the horizontal and verti-cal displacements compared to the theoretical design alignment.

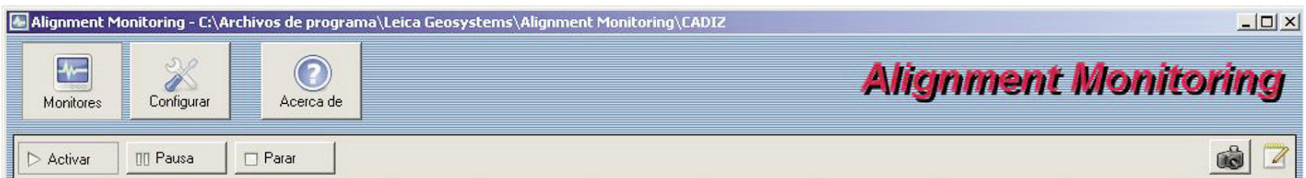
Minimum quality 3D check values were established, and differences in chainage and horizontal/vertical distances to the reference line were continuously analysed.



All WGS84 coordinates were transformed to the old Spanish Geodetic Reference System (UTM 30N European Datum 1950) using the proper 3D transformations provided by the customer. It was also possible to use the new Country Specific Coordinate System (CSCS) together with a geoid model provided by the Spanish Geographic Institute.
3 metre hydraulic pushing cycles can clearly be observed when seeing both horizontal and vertical displacement graphics.







	Tipo	Estado	Monitor	Actualizado	X	Y	Z	P.K.	ΔP.K.	ΔOffset Hz	ΔOffset Vt
☐			90 D	14:05:26	442.532,03	4.482.157,46	507,77	4.941,43	0,68	0,01	-0,06
☐			90 I	14:05:26	445.244,94	4.487.223,44	519,28	4.948,12	0,68	-0,01	0,03
☐			45 D	14:05:25	442.532,03	4.482.157,46	507,78	4.941,43	0,68	0,01	-0,05
☐			45 I	14:05:25	445.244,94	4.487.223,43	519,28	4.948,12	0,68	-0,01	0,03

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- when it has to be **right**