The prevention of landslides on the unstable face of the Ruines de Séchilienne

ALERT sends key information to the technicians of Lyon's *Centre d'Etudes Techniques de l'Equipement* (C.E.T.E.)

Context

The prevention of serious natural hazards is a major challenge for modern society. It is both a social challenge, because public authorities cannot remain inactive when populations are under threat, and a technical one, because the forecasting of the progression of phenomena – the key to all prevention – calls upon high-performance measurement methods.
The Ruines site is located in the lower valley of the Romanche, on the right bank of the river, 2.5 km downstream from the village of Séchilienne and 15 km southwest of Grenoble.
The movement of the face, which appears to have been initiated by post-glacial decompression phenomena, affects a total surface area of 70 ha.

The section most likely to rupture in the short term represents a volume of 3.2 million m3, bordered on each side by a similar volume of rock that may cause regressive landslides.
The greatest risk in the event of a landslide would be to the RN91 highway and, in the event of significant regressive landslides, the creation of a natural dam blocking the bottom of the valley. This fragile dam, behind which a lake could quickly form during a flood period, would pose a direct threat to the built up areas downstream, in particular the town of Vizille.

In the interest of prevention, several projects were undertaken

- The digging of a channel to divert the Romanche to the south side of the valley over a distance of 1200 m. Upstream, the head of this channel is blocked by a fuse plug dam, which would enable the Romanche to be diverted should the low-water channel be obstructed by a landslide,
- The digging of a diversion for the RN 91 on the embankment that constitutes the left bank of the diversion channel,
- The materials made available as a result were put to use in the building of a protective barricade between the Romanche and the new route. The cramped nature of the site has unfortunately not enabled this barricade to be set up in an optimal manner,

11 chemin du Vieux Chêne ZIRST 4201 F-38942 Meylan cedex
micromedia@micromedia-int.com
Tel. +33 (0)4 76 04 11 00 - Fax. + 33 (0)4 76 90 24 76

- The digging of an emergency diversion tunnel for the Romanche, which will prevent a lake from forming if the valley becomes blocked (discharge limited to 50 m3/s, but which allows annual flooding to be dealt with).

Another response to this risk has been the drawing up of a contingency plan by the Isère Department Prefecture. The effectiveness of this plan, at least in terms of its preventive aspects, relies heavily on the reliability (in all types of conditions) of the alert mechanism, which must be able to detect the early signs of a landslide occurring (initial acceleration in particular) in order to trigger the various alert and population evacuation phases as effectively as possible.

Set-up of sophisticated monitoring on the mountain face

An employee of the *Laboratoire Régional des Ponts et Chaussées* (Regional Bridge and Road Laboratory), a specialist department of Lyon's *Centre d'Etudes Techniques de l'Equipement* (Technical Facilities Research Centre), is on duty at all times to check that the movement thresholds set previously are not exceeded. Sophisticated monitoring is carried out thanks to three independent and complementary systems:

- An extensometric remote measurement network, which allows 33 sensors located at the site's main fractures to be constantly monitored,
- An automated geodesic monitoring network comprised of 50 measurement beacons. Measurements are conducted using optical geodesic methods,
- A distance measurement system that uses microwaves to monitor around twenty strategic markers at all times, whatever the conditions.

Technical aspects

Installing a solution linked up using a conventional network was not an option, in view of the fact that the three monitoring techniques are spread over two remote sites. It was therefore decided that a common core would have to be created for all three measurement systems, as well as a network management facility that would allow data to be pooled.

Lyon's *Laboratoire Régional des Ponts et Chaussées*, which was placed in charge of supervising the site and updating the remote monitoring system, opted for a core based on the PANORAMA supervisor, which is distributed by Europ Supervision, and the implementation of ALERT for the transmission of alarms to the various operators concerned. For this data to be harmonised, it was processed using DELPHI, distributed by Borland using developments specific to each of the three surveillance methods used, and then declared via a PANORAMA SQL server. This development was carried out by the Automation Department of the company P.D.A..

The ultimate aim was to be able to archive both actual and calculated data, and to create forecast and progression curves that would allow an acceleration of land movement to be foreseen several hours or even days in advance, thus anticipating major risks and enabling their effects to be forestalled.

In terms of data transferral and communication, it was decided that the modems used would be connected via a Public Switched Telephone Network (PSTN).

Description of the solution

The solution was initially deployed at the Thiebauds site. It was equipped with two redundant PC's and set up to query the other applications used, in order to centralise

the data and send it using a PSTN modem to the operations centre for unstable mountains at the CETE in Lyon. In the event of an emergency, the site can accommodate all the personnel needed in such situations and provides them with the facility to carry out all the actions required for data to be monitored and forecasts to be conducted, in real time, throughout the installation (Thiebauds and Mont Falcon).

Several types of alarm are monitored:

- An alarm triggered when the change from one measurement to the next on the same sensor exceeds a predefined and programmable threshold,
- A forecast alarm: based on a reference period (known period of between 24 and 72 hours), it is possible to predict the measurements that should be obtained over the coming hours, by linear regression,
- An alarm triggered if the main server is out of order and the backup server has taken over,
- An equipment fault alarm: a radio transmission failure or a measurement acquisition failure.

ALERT then sends these voice alarms (via the PSTN) to staff on duty or on call, who have been given different instructions to follow depending on the voice alarm received.

Summary

According to the CETE, the new monitoring system they have installed allows greater flexibility during use and therefore speeds up reaction times.