SinoGNSS®
By ComNav Technology Ltd.

GNSS Monitoring Solution for the Second-largest Hydropower Station Xiluodu in PR China

Xiluodu Hydropower Station

CHALLENGE

- 24/7 automatic and reliable monitoring system for the structural integrity of the hydropower station
- Monitoring 6 landslides with complicated terrain
- Remote access to monitoring data with an automatic alert system

CUSTOMER

HYDROCHINA - Chengdu Engineering Corporation Limited.

http://www.chidi.com.cn/en/1117.html

DATE

April 2014

LOCATION

Xiluodu Town, Sichuan Province, PR China

Fig 1. Observation site near landslide area

PROJECT SUMMARY

Instruments:

SinoGNSS M300Pro GNSS Receiver

AT330 GNSS Geodetic Antenna

Software

SinoGNSS CDMonitor software

Compass Solution software

Landslide analysis software

Other

Wireless device server and access point

Solar panel and lightning arresters for survey sites

Personal computers with internet connection

BENEFITS

- 24/7 uninterrupted monitoring system ensuring safety of power station and GNSS equipment
- Reliable performances with multiple monitoring surfaces
- Remote access to monitoring data, graphical display of measurements
- Automatic alert via short messages and e-mails

Xiluodu is a multipurpose project including power generation, sedimentation, flood control, downstream navigation improvement. With its 13.86 million KW gross installed capacity and 57.12 billion KWh average annual power generations, Xiluodu Hydropower Station has become the main power supply for "West-east power transmission" in China. To ensure its smooth operation, Chengdu Engineering Corporation Limited acquired an automation deformation monitoring solution from ComNav Technology in April 2014 for continuously monitor overall deformations of the Xiluodu Hydropower staiton.

Located on the Jinsha River between the border of Sichuan and Yunnan province, Xiluodu is the second-largest hydropower station in China. The complicated terrain around the station is distributed with many landslides, which are very easy collapse and deformation, especially when large water storage. To ensure the long-term safety of station infrastructures and employees, a continuous slope monitoring system that can simultaneously monitor all landslides is required.

Another challenge for the constructor is that this system should provide remote data access and automatic alert if any observation value exceeds limit level.

Overall considering the above difficulties, ComNav Technology decided to build totally 61 M300Pro GNSS Receivers along with 61 SinoGNSS AT330 GNSS Geodetic Antenna on monitoring sites, one master control centre in customer's office, and 6 sub-control centres around landslides.

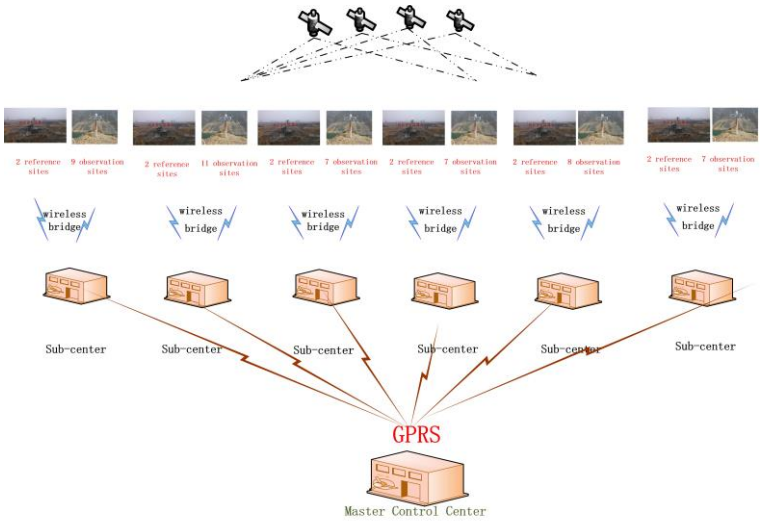

Fig 2. System Design

System design and setup

The GNSS landslide monitoring solution consists of GNSS receivers; rain gauges; solar power supply and lightning protection devices, communication links as well as control servers with data processing and analysis software. The overall system design includes (Fig 2):

- Built observation sites around landslide areas
- Transfer raw observation data to sub-control centre through wireless bridge
- Output three-dimensional coordinates calculated by CDMonitor software from sub-control centre to master control centre
- Overall monitoring result display in master control centre

There are mainly six landslides that required real-time monitoring around the hydropower station. In order to check structural integrity of Xiluodu, each landslide area was equipped with two GNSS base stations on nearby stable rocks, several monitoring stations on slopes, as well as a set of automatic rain gauge. All the base stations formed a datum network through control survey, which ensured other monitoring sites under a unified coordinate system. SinoGNSS M300Pro GNSS Receiver, AT330 Geodetic Antenna, along with solar power supply and lighting protection system were equipped in every observation site (Fig 1).

Monitoring network

Communication link was established between the GNSS receivers and dedicated monitoring computers through wireless bridge. These computers are located in a different office near each landslide area with SinoGNSS CDMonitor software, responsible for calculating high-accuracy coordinates of observation sites in real time. Then all these real-time coordinates data are transferred to the master control centre through GPRS network for enabling easily output monitoring and analysis results. Furthermore, the reliability of overall network is ensured by using uninterrupted power supplies (UPS) and deformation data are frequently backed up.

Deformation data

The monitoring data is available in real-time for displaying through SinoGNSS CDMonitor software, so that monitoring staffs are able to directly check deformation values of all observation sites (Fig3).

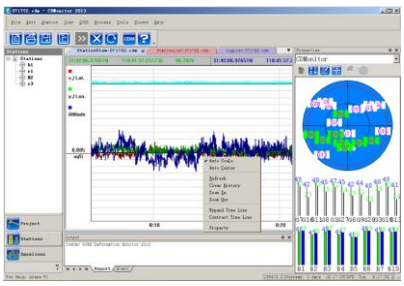

Fig 3. CDMonitor software

To ensure high accuracy of SinoGNSS monitoring system, a comparison test was conducted between GNSS receivers and

classical total stations. The result shows that SinoGNSS monitoring

Table 1. Comparison between GNSS Receiver and Total Station

point	GNSS displacement/m			Total station displacement/m			Displacement(GNSS-TS)/m		
	△X	△Y	△H	△X	△Y	△H	△X	△Y	△H
TP10	0.023	-0.04	-0.0216	0.0271	-0.0378	-0.0165	-0.0041	-0.0022	-0.0051
TP09	0.0159	-0.0281	-0.0127	0.0169	-0.0259	-0.0182	-0.001	-0.0022	0.0055
TP04	0.0126	-0.0224	-0.0153	0.0061	-0.0234	-0.0158	0.0065	0.001	0.0005

system is able to reach 3mm horizontal accuracy and 5mm vertical accuracy (Tab.1), which ensures responsible staffs to make right decisions when movement happens.

With these real-time observation coordinates, end customers also can display graphical and numerical deformation reports from other third party analysis software. In this case, SinoGNSS Landslide monitoring analysis software was applied. Furthermore, this software is able to automatically inform the responsible staff via short message or e-mail when displacement exceeds limit levels that surveyors set beforehand.

Conclusion

ComNav Technology realized the design, the delivery of all equipment, the complete installation and tuning of this GNSS Monitoring Solution for the Second-largest Hydropower Station Xiluodu in PR China. That solution allows to alert and alarm efficiently in case of displacements of monitoring sites and effectively predicted landslide events since its implementation.

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