Although an effective tool for deformation monitoring of large structures and high-risk slopes, GPS can also entail a high-cost disadvantage in large projects. A remote-controlled monitoring system using an electronic switching device for a multiple antennas watches the steep slopes under construction at the Xiaowan hydropower station in China.

Xiaowan hydropower station on the Lanchang River in Yunnan province, China consists of a double-curvature arch dam, 292 meters high. Construction began in January 2002 and is expected to conclude by the end of 2010. Steep slopes in the river valley, both natural and engineered, pose critical problems for construction engineers. Heavy rain or further rock excavation could cause slopes near the arch dam to slide. To reduce landslide risk, engineers have employed several conventional techniques, traditional surveying equipment, and specialized geotechnical instrument to monitor the stability of the high-risk slopes. They also used GPS as a monitoring tool for high-risk slopes.

Usually, several observation points must be monitored to fully understand the stability and any ongoing deformation that could cause slope failure. For example, it required 16 observation points to adequately monitor a high-risk slope measuring 300 by 500 meters, or 0.15 square kilometers.

GPS offers greater accuracy, is highly automated and less labor intensive than the conventional techniques used during the stability monitoring of the high-risk slopes. However, GPS does have disadvantages, the major drawback being the high cost associated with placing a permanent GPS receiver at each monitoring point. Xiaowan power station has many steep slopes; therefore, conventional GPS monitoring methods have significant limitations here.

We have implemented a new approach linking a single GPS receiver with multiple antennas mounted at several monitoring points. We developed a dedicated electronic switching device — the GPS multiple-antenna switch (GMAS) — to connect the receiver with the antennas, significantly reducing the required hardware investment.

Other technologies include a new electronic switching device for GMAS, General Packet Radio Service (GPRS) wireless data communication, and a microamplifier.

System Description

Figure 1 outlines the GPS multiple-antenna system for slope-deformation monitoring. The system includes three main parts: the

An experimental version of this methodology appeared in the March, 2000 issue of GPS World, in an Innovation column by Xiaoli Ding and Yongqi Chen, co-authors of this article, with four others.

The photo on this page shows a different, completed dam in the same region of China, with the same double-curvature arch structure. The photo at top of the next page depicts an architectural model of the Xiaowan dam, with Number Two steep slope, referenced further on, on the righthand side.

The magazine's cover shows a base station located on Number Two steep slope.