Interpretation of First Results from the Automated and Integrated Monitoring Scheme at Diamond Valley Lake in California

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ABSTRACT

In 2000, the Metropolitan Water District (MWD) of Southern California finished construction of Diamond Valley Lake (formerly the Eastside Reservoir), Southern California's largest water storage reservoir, with a capacity of nearly one billion cubic metres of water. This $2-billion project, located near Hemet, California (about 160 km southeast of Los Angeles), was designed to secure six months of emergency water for about 16 million inhabitants. It was created by enclosing a valley approximately 7.2 km long and 3.2 km wide with three large earth/rock filled dams of 2.9 km, 3.2 km and 0.8 km lengths and up to 85 m high. The filling of the reservoir began in December 1999 and is estimated to take between three and five years, depending on the availability of water throughout the western United States. At the time of writing this paper (December 2001), the filling was about 67 % complete.

Due to the dimensions of the project and its location within the earthquake prone area, an extensive monitoring program has been developed in order to provide a warning system and confirm that the dams and foundations are functioning as intended. The monitoring instrumentation includes an extended array of geotechnical instrumentation, strong motion accelerographs, active GPS stations, and a fully automated terrestrial geodetic system for Dam Deformation Monitoring (DDM). The latter has been operational since October 2000. This paper reviews the design and implementation of the DDM system and gives an evaluation of its performance over the first year of operation.

The automated DDM system was designed to detect displacements of targeted points on the downstream faces of the dams with an accuracy of 10 mm at the 95% confidence level. Eight Leica TCA1800 robotic total stations (RTS), permanently installed in specially designed shelters, perform automatic measurements to 232 targets (prisms) at pre-programmed time intervals. To randomise effects of atmospheric refraction, the observation cycles have been distributed at 8 hours time intervals at 4 am, 12 noon and 8 pm over the first 3 days of each week. An average of 10 cycles is taken as the final result for weekly reporting purposes. In emergency cases (e.g. an earthquake), the RTSs will automatically “wake-up” by the active GPS warning system.

All functions of RTSs, automatic data collection, and automatic data processing are controlled by DIMONS software developed at the University of New Brunswick. DIMONS performs an automatic data reduction (station adjustments, EDM corrections), identification of unstable reference or RTS points using the iterative similarity weighted transformation and automatically updates and displays the coordinates of the targets after each cycle of observations. The stations are remotely operated via a wireless LAN radio network and TCP/IP connections to the industrial "black box" computer at each station. The collected data and updated coordinates are available immediately for analysis at the MWD office located 120 kilometres away.

At the time of writing this paper (December 2001), all robotic total stations and the supporting DIMONS software have worked well above expectations since October 2000. They have supplied reliable weekly data without any major interruptions within the designed accuracy. Recently, occasional problems have occurred with the power supply (batteries rechargeable by solar energy). The problem has been solved by minimising the power draw by the industrial computers at RTS locations and slightly modifying the schedule of observations. The effects of refraction, as expected, proved to produce significant errors in individual cycles at some targets. They are, however, well randomised and minimised by taking an average of ten cycles every week as the final reporting result.

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