Old Structures, Modern Methods

For decades, the old bridge and tunnel had looked right at home in the rugged, mountainous terrain of southeastern British Columbia. But it was time for a facelift. Elko Tunnel, which dates to the 1900s, needed a survey to determine if it could handle the transport of large coal dump boxes from a nearby mine. And Wycliffe Bridge—built in the early 1930s—needed to be rebuilt.

With both surveying projects scheduled for 2009, the British Columbia Ministry of Transportation and Infrastructures (BCMoT) needed to complete the measurements with available manpower resources and under challenging conditions. To handle the work, the ministry combined GNSS surveying, reflectorless total stations and spatial imaging to collect the needed data safely and efficiently. BCMoT has used spatial imaging extensively for two years, measuring everything from highway intersections to rock slope mechanics and stability as well as surveying inaccessible slopes.

Multiple Challenges

The Wycliffe Bridge, which spans the St. Mary's River, is a timber structure supported by a pair of concrete piers. It's roughly 115 m (380 ft) long, including a central span and two structures connecting the center span to the road. The BCMoT team needed to survey the bridge for deck replacement and improvements to the superstructure and approaches. Steep slopes, the river and dense vegetation made it difficult to see, much less access, the bridge's piers and support structure. Conventional methods would have required many days of work to capture the bridge's columns, beams, cross members and decking. By comparison, scanning would be faster and safer, and would provide more detail than could be obtained using conventional methods.

Top and bottom left: The Wycliffe bridge rebuild will increase the bridge's load limit, improve safety and extend the life of the structure. Bottom right: BCMoT survey crew—Geoff Methuen, Rod Ralston and Luke Dickieson—set control points for the project using Trimble R8 GNSS receivers. – Photos courtesy of BCMoT

The BCMoT crew used static GNSS to establish control points around the bridge. Next, they used a Trimble VX™ Spatial Station to scan the bridge from four different locations, resecting the instrument's coordinates from the control points. The team scanned the entire structure from below the bridge deck, and used direct reflex measurements to capture additional details on the main span and concrete pillars. They collected imagery using the instrument's built-in high-resolution camera. The surveyors then used a Trimble R8 GNSS system for RTK topographic surveys, and to locate nearby cadastral markers. Using the Trimble VX as a total station, they collected additional topography in areas not suited for RTK. The surveyors could minimize the amount of time they spent in the roadway, and the entire survey was carried out without closing the area to vehicle traffic.

Originally constructed for rail traffic, the Elko Tunnel lies on the Crowsnest Highway connecting Elko and Fernie. The tunnel is roughly 100 m (330 ft) long, and is sized to fit the trains of the early 1900s. The survey plan was similar to that for the bridge, with the crew setting control points using post-processed GNSS. Inside the tunnel, surveyors used the Trimble VX to conduct nine scans from five different setup points. With the scanner's position established by resection from GNSS points outside the tunnel, the team configured the instrument to automatically collect evenly-spaced points on the tunnel floor, walls and ceiling. Outside the tunnel, RTK GNSS collected topographic data along the highway corridor. During the scanning, the instrument could operate unattended inside the tunnel, and it was not necessary to shut down traffic. Because the Trimble VX and Trimble R8 GNSS systems use the same controller and field software, the crews could combine their work into project files in a common, georeferenced coordinate system.

Data Processing and Analysis

Work on the bridge called for a large number of measurements to depict the existing structure. For the tunnel, the emphasis was on analysis to determine clearances and information related to a possible roadway enlargement, and the team collected approximately 56,000 points. On both projects, BCMoT used Trimble RealWorks Software to check and analyze the scanning data. They combined the point clouds and images with data from GNSS and the Trimble VX into a single data set. Technicians created a 3D model of the tunnel and developed a contour map at intervals of 10 cm (0.3 ft). The contours (now in the form of 3D polylines) were exported to the ministry's CAD systems for cross section analysis, plotting and design.

Looking back on the projects, Mike W. Skands, survey and mapping manager for the ministry's southern interior region, said that the teams completed their surveys within the allotted timeframes and provided the high-quality data needed for planning and construction. "You could do the field work in less time using conventional equipment, and then make assumptions based on a few essential measurements," he observed. "But by using the scanning functionality, we saturated the subject of our survey with 3D points and supplemented it with georeferenced images. It eliminated assumptions and provided a superior representation."

Skands said that the automatic and remote control features of the Trimble VX were important on the tunnel project, where cold weather hampered the work. The instrument's Trimble VISION™ video capability allowed the surveyors to "see" what the instrument saw, a valuable advantage when the bridge surveyors needed to measure in difficult places. Skands believes that the new technologies enabled the tunnel and bridge surveys to be completed with a minimal crew, even under punishing conditions. "Because the required manpower has been reduced to one third or one quarter of what it used to take, we can use our resources more efficiently and on multiple projects," Skands said.

See feature in the June issue of CE News: www.cenews.com