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AUGUST 2008

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Walt Narkie

REBUILDING I-35W

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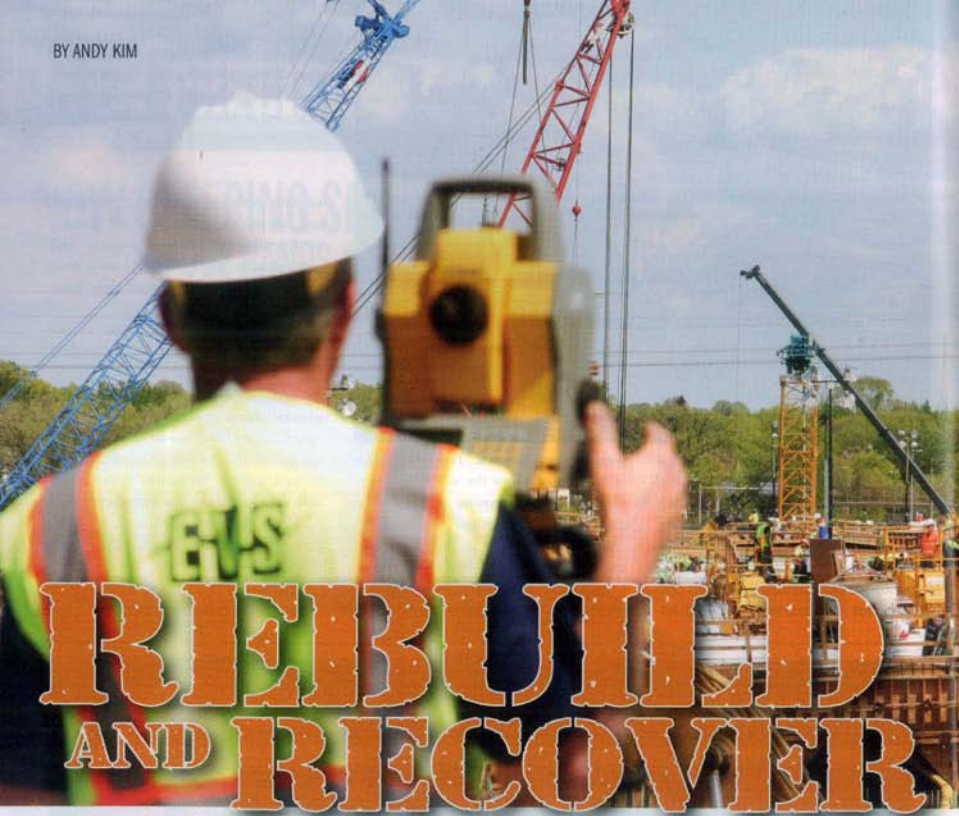
BY ANDY KIM



REBUILD AND RECOVER

Surveying the fast-track reconstruction of the Interstate 35W bridge in Minneapolis.

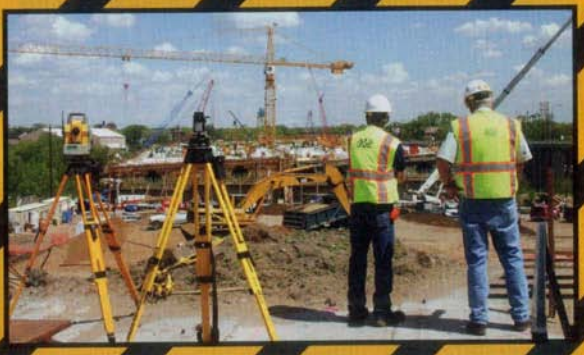
During peak rush hour on Aug. 1, 2007, Minneapolis' Interstate 35W bridge—Minnesota's fifth-busiest overpass carrying 140,000 vehicles daily—collapsed into the Mississippi River. Surveillance video showed the eight-lane steel truss-arch bridge crumple into a cloud of dust. Numerous cars and people fell from sections as high as 115 feet above the river. Thirteen people died, and 145 more were injured. The tragic accident brought both the national and international spotlight to the North Star State.

Numbers of workers—including surveyors—were onsite immediately to carry out rescue and recovery efforts. In remarkable time and with precision accuracy, surveyors established control, collected forensic data, set targets for a LiDAR flight, set new horizontal monuments for reconstruction efforts, and provided construction-site surveys and as-built surveys for the design/build phase. A new bridge—the St. Anthony Falls Bridge—is expected to be ready for travel next month.

Recon for Rescue and Recovery

Surveyors with the FBI and the Minnesota State Patrol immediately established a preliminary control network. Next on the scene were surveyors with the Minnesota Department of Transportation's (Mn/DOT) Metro District Survey Section led by Land Survey Manager Brad Canaday. Other Mn/DOT districts sent crews to help the Metro District with their current projects, thereby freeing up Canaday's crews for the I-35W efforts. At the bridge site, Canaday's crews were tasked with capturing detailed forensic information and documenting the wreckage for the investigation into the collapse. Establishing control was the critical first step.

Due to the urgency of the situation, Canaday's crews decided to establish control using real-time kinematic (RTK) GPS technology with Trimble (www.trimble.com)



Opposite: Walter Narkie, EVS crew chief, uses a Trimble 5603 Total Station while overlooking construction. Top right: Narkie and EVS Survey Section Manager Brian Henry look northward at the south abutment while conferring about the staking of the gabion basket walls adjacent to the south abutment. Above: Project site view looking west at Pier 2 from the 10th Avenue Bridge adjacent to the new St. Anthony Falls Bridge.

R8 GNSS equipment. While static GPS would have yielded greater accuracy, it requires additional collection time–and time was of the essence on I-35W.

After control setup, Canaday and his crew members set out to collect forensic data of the scene. They immediately realized that 3D scanning technology would be the most efficient way to collect data on the wreckage before removal operations commenced. A scanner allows a user to collect data from a distance; at the I-35W site, it allowed surveyors to collect data without entering the river or climbing on the wreckage.

Within two days after the collapse, Gary Troge, surveys and scanning specialist for Mn/DOT, was onsite with a Leica Geosystems (**www.leica-geosystems.us**) ScanStation. Initially, two two-person crews worked for 13 straight days and periodically thereafter as crews removed wreckage.

Part of this effort involved recovery of victims. According to Troge, a great deal of respect and attention was paid to the recovery effort. On many occasions, any worker not involved in the recovery effort was ordered off-site. Therefore, survey efforts were often paused for hours. When crews returned to their work, the ScanStation's capability to reorient itself allowed them to restart their activities with minimal effort.

In the end, more than 372 million points were collected from 68 setups–all done amid numerous federal- and state-agency staff workers who were performing various survey tasks under pressure.

At the same time, Mn/DOT surveyors set targets for a timely LiDAR flight to capture the scene. The Minneapolis office of geospatial solutions provider Aero-Metric furnished high-resolution color oblique aerial photographs just 16 hours after the collapse and soon after performed aerial photography and LiDAR services.

Geodetics in the Dark

Survey work for reconstruction efforts began 13 days after the collapse. The Mn/DOT Geodetics Unit led by Geodetics Engineer John Barke, PE, began by setting new horizontal monuments on both sides of the river using Trimble 4000 SSI GPS receivers with Trimble Zephyr antennas. Barke and his team then tied in local city

I-35W: Then and Now

The original Interstate 35W bridge was officially designated "Bridge 9340" and opened in 1967. The 1,907-foot-long, 14-span bridge made of steel trusses was constructed in three years at a cost of $5.2 million. The two support piers for the main trusses were located on the opposite banks of the Mississippi River. The center span of the bridge consisted of a single 458-foot steel arched truss over the river.

The new 1,216-foot-long bridge, named the St. Anthony Falls Bridge, will carry five lanes of traffic in each direction on two separate roadbeds 8 feet apart. Its total width will be 189 feet—some 80 feet wider than the bridge it replaces—and it will have 13-foot-wide right shoulders and 14-foot-wide left shoulders. (The previous bridge had no shoulders.) The bridge design, which focused on being aesthetically pleasing and complementing its environment, follows the primary theme of "Arches, Water, Reflection." St. Anthony Falls will be a white concrete bridge with colorful LED lighting and landscaping.

With 400 workers onsite during the day and 200 at night, Mn/DOT announced on April 8, 2008, that it had reached the halfway point of the bridge's construction. The bridge is proposed to be completed by September 2008.

and county monuments as well as two original marks on the adjacent lock and dam. Levels were run across the 10th Avenue Bridge, the historic Stone Arch Bridge and a railroad bridge adjacent to I-35W.

What would normally be a set of straightforward tasks was made difficult by the unique nature of the scene. The ability to enter the site and move around, for instance, was restricted due to high security. Every location setup required an explanation as to why, where and how long it would take for the task. "Time constraints, security, sensitivity of the investigation and restrictive work environments all made this one of the most challenging projects Mn/DOT has worked on," Barke says.

Additionally, the disruption to normal traffic patterns pushed traffic onto local streets. This required late-night and early-dawn sessions to occupy monuments in existing streets. Working at such times required extra vigilance in watching for drivers unaccustomed to seeing workers in the streets and required equipment such as hard hats with miners lights and flashlights.

Despite these challenges, the geodetics unit was able to release the adjusted horizontal and vertical datum to its online database on Oct. 22. It was then time for the design/build process to move forward on the bridge's reconstruction.

Designing the New I-35W

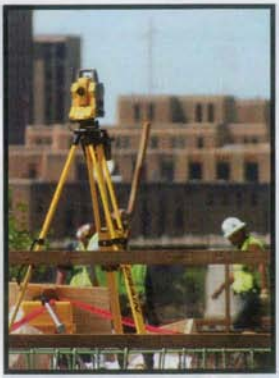
In support of political pledges to fast-track the bridge's reconstruction, Mn/DOT moved quickly through the bidding process and, on Sept. 19, selected the Flatiron-Manson Joint Venture team, which consisted of Flatiron Constructors, Manson Construction Company and bridge designer Figg Engineering.

Flatiron-Manson and TKDA, a local St. Paul firm and member of the Flatiron-Manson design team, selected EVS Inc., a surveying and engineering firm based in Eden Prairie, Minn., to manage and perform surveys for the new St. Anthony Falls Bridge, as the overpass is now called. EVS Survey Section Manager Brian Henry, PLS, led the overall design survey effort.

"In forty-four years as a surveyor, I had seen many massive interstate highway projects," Henry says. "When approached to be survey manager for a high-profile project such as this, my feelings reflected both excitement and a bit of apprehension about the schedule and the design and construction processes happening simultaneously." These feelings were the driving force behind Henry's project direction. He quickly and efficiently set a course for his team.

EVS' initial task was to establish, expand and verify control for the site. Using Trimble

Bridge deck near south abutment.



A Trimble 5603 Total Station is set up on the bridge deck near the north abutment of Pier 4.

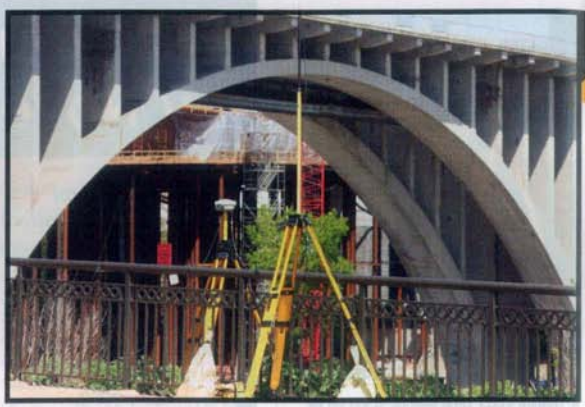
5603 Total Stations and Trimble R8 GPS units with Glonass capability, EVS surveyors expanded the Mn/DOT geodetic control released on Oct. 22, ran levels to verify elevation on new control and re-sected control points as an additional accuracy check. These control points were required to be within millimeter accuracy, according to the casting yard tasked with building the new bridge sections.

A topographic survey was then performed to assist the designers. The St. Anthony Falls area where the bridge is located is the historic point around which the city of Minneapolis developed, and a few local features presented the EVS and TKDA crews with unique data-collection challenges.

Pier 4, for example, was located close to a historic 50-foot-tall limestone wall that included protuding rock outcroppings from steam tunnels positioned behind the wall that help heat adjacent University of Minnesota buildings. The outcroppings and the concrete appurtenances from the tunnels created obstacles that would have interfered with the new Pier 4 installation. Therefore, designers required a 3D model of the area so they could fine-tune the final position of Pier 4 around the structures.

Additionally, 12-foot-wide storm water tunnels on the north and south banks directly affected the new locations of Piers 2 and 3 on the riverbanks. Surveys were taken from inside the tunnels and

A Trimble R8 GNSS base station collects data on a control point in front of the 10th Avenue Bridge.



through potholing, a technique in which EVS surveyors dropped a rod into surface-drilled holes to obtain coordinates and elevations.

Crew members were also challenged with the existing drilled shafts, which were determined to be difficult to remove near Piers 2, 3 and 4. Therefore, surveys tied out the locations of the drilled shafts as they were exposed. This critical location information was necessary to ensure that they would not interfere with the boring of the new drilled shafts.

Constructing the Corridor

In November 2007, shortly after the design surveys were complete, EVS crews began construction-site surveys. Initially, EVS staffed two two-person crews five days a week for 10-hour shifts. In a few weeks, however, additional contractor personnel were added, and Flatiron made the decision for surveyors to be onsite 24/7.

Initial tasks involved laying out the casting beds on the in-place bridge concrete roadway slab on the south side of the bridge to millimeter accuracy. As each drilled shaft and footing was built, and as each pier and abutment was put in place, as-built surveys were performed. In many cases, manlifts were required for the rodperson to get the shot, which added significant time to the task.

As construction progressed, forms were adjusted per the survey data provided. Therefore, timing and delivery of data was critical. Using wireless-capable laptop computers in the field, EVS crew members were able to deliver data quickly to the office and to the designer. This enabled information to be transferred seamlessly between the day and night crews, a necessity in split-shift activities.

The night crew, however, encountered challenges that the daytime crew didn't. Short winter days and long nights called for crew members to work in hard hats with miners lights and with portable jobsite lights. The intense light combined with some cold Minnesota winter nights–when wind chills dropped to below 30 degrees Fahrenheit–often made the LCD displays difficult to read and sometimes required surveyors to warm up the equipment in the truck or under their clothing prior to use. The Autolock feature on the night crew's Trimble 5603 Total Station was especially useful at night when the rodperson disappeared from sight in snow flurries or in the dark.

In February 2008, after two months and near completion of the installation of the piers and abutments, the long shifts began to wear on the EVS crews. Rani Engineering, a local firm, was brought in to supplement and give the worn surveyors a reprieve. Rani had two two-person crews working during the day and one two-person crew working overnight. Rani's

surveyors began construction staking of the bridge while EVS crews shifted their attention to civil and roadway needs. Rani used a combination of Trimble 600, 5600 and S6 total stations and R8 GNSS units to perform accurate work on schedule. The R8 units especially saved time since the surveyors did not have to set temporary control time after time to get stakeout down in the bridge barrels.

Todd Mecke, construction survey manager for Flatiron, was brought on to the project to help with the increased coordination required for the bridge staking once the piers were close to completion. Mecke created more than 120,000 stakeout points to within .02 of a foot on everything from the centerline of the bridge spans to the edge of the deck. Steve Moore, a survey consultant specializing in large high-accuracy projects, worked with Mecke to make adjustments as small as .001 of a foot to control, alignment and stakeout points.

A Bridge to Recovery

The reconstruction efforts of I-35W in Minneapolis continue at a fast pace toward completion. Survey crews have been working around the clock on the bridge and on the adjoining freeway reconstruction. It has been a challenging yet satisfying project for all involved.

"Working on a monumental project that included tight time schedules and frequent design changes make this project one of the most interesting and rewarding in my whole surveying career," says EVS' Henry. "It is an honor to team with a dedicated group of surveyors, designers and engineers working diligently–and often amid chaos–to ensure the success of this project. The first time we staked this bridge back in the sixties, it took years to complete. Now it will take only about a year. The advance of surveying technology in the road/bridge building process definitely helped meet the aggressive time schedules."

This month, one year after the tragic collapse of Aug. 1, 2007, travelers of I-35W look forward to a new corridor that will replace the notable bridge in Minnesota that has served as a catalyst to new transportation and civil infrastructure mandates. The surveyors working in the investigation of the collapse and its reconstruction provided foundational support to the project while gaining an appreciation for the efforts of all involved. As Henry says, "It is a tribute to building a team that 'can do.'"

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