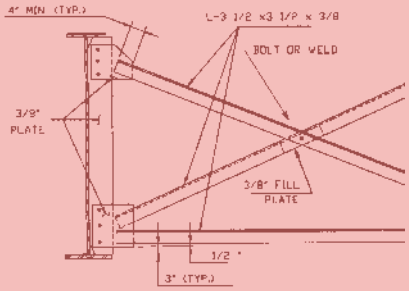

No. 19
Bridge Crossings
Practical Information for the Bridge Industry

Steel Bridge Fabrication Drawings

Electronic Distribution, Review and Approval Gains Acceptance

By Conn Abnee

Around the country, DOTs are moving slowly but steadily toward electronic review and approval of steel fabricators' shop drawings for steel bridges. New York, for example, first tried this technique in the fall of 2000 for a bridge over the Long Island Expressway in Little Neck, Queens. Since then, the technique has been applied to more than 20 steel bridges in New York. The New Jersey DOT first approved the use of electronic review and approval for a large, complex, fast-tracked multiple steel-bridge project completed in February 2003. In both cases, AISC-member fabricator High Steel Structures (Lancaster, PA) spearheaded the effort to try electronic approval of shop drawings.

New York's Experiences

The New York DOT's Paul Rimmer, Supervisor of Metals Engineering, says that the technique is gaining ground. "High Steel Structures, as well as a collaborative of the National Steel Bridge Alliance and AASHTO, are encouraging electronic document review and approval to speed project delivery and bring down their costs," he said. "But much of the fabrication and detailing industry has yet to move in that direction."

Rimmer notes that approval schedules in the past relied on the U.S. Postal Service to distribute copies of the shop drawings and requests for information—often proceeding through a linear chain of communication among the detailer, fabricator, contractor, consultant, and owner. The process took months.

Later the various parties switched to overnight services such as Federal Express and UPS. Related package-tracking services provided oversight of the distribution process and alerted expeditors to lost or misplaced drawings. "Electronic distribution along with web-based document management represents the next stage," Rimmer said. "They provide improvements in document management, offering greater speed, security, and control."

Don Lee, Engineering Expeditor for High Steel, notes that the construction industry originally considered transferring files via the Internet. "We thought we might be able to e-mail shop drawings created by MicroStation and AutoCad to a customer," says Lee. "But we didn't think e-mail provided sufficient horsepower to do so because some Internet service providers have a limit on file size for e-mail attachments," he adds.

The solution came in the form of a traditional Internet technology called File Transfer Protocol (FTP). This technique acts specifically to transfer large files over a network like the Internet. It also offers several levels of passwords for security. Unlike e-mail, which requires that electronic files be attached to messages, FTP handles files directly without the overhead of encoding and decoding the data. It includes functions to log onto the network via passwords—listing only directories that the user has privileges to see—and permits the downloading and uploading of files. Inexpensive software programs such as FTP Voyager (about $40, www.Rhinosoft.com) permit the interested parties to log on to the server, find the pertinent files, and schedule file transfers.

Another obstacle was the incompatibility of the shop-drawing files created by the various proprietary software packages. "These files are complex, with numerous functional image, algorithm, and data layers," Lee said. "We needed the capability to ensure security of the comments and stamps-of-approval on drawings, which are legal documents. Annotations and stamps-of-approval must incorporate inte-

New Jersey DOT interchange project linking Routes 1, 130, and 171 made extensive use of electronic document approval to meet 18-month timeframe.

grated security to prevent them from manipulation."

Even though the software companies were introducing ways to securely annotate the drawings with a process called red lining, the basic incompatibility of different internal processes created nearly insurmountable difficulties.

"Finally, we hit on the idea of converting the shop-document files from a vector- to a raster-based technology," he said. "This process creates an image of the resulting drawing, much like the hard copies familiar to everybody. We settled on the TIF (Target Image File) and PDF (Portable Document File) formats."

Free software is available for viewing these files. "Adobe provides a free reader for viewing PDF formats, but the program to edit or annotate PDF formats is relatively expensive," he said. "The imaging software that comes with every Windows-based PC handles multi-page TIF formats, and even includes some rudimentary annotation tools."

Lee says he prefers the TIF format. "We've used both formats, but many smaller offices don't have the right equipment to quickly print PDF files. In addition, many of our DOT customers have settled on TIF files as their choice of format for both bid sets and final-shop drawings. These same states have often picked the PDF format for letter-size and web-document exchange."

Both file formats permit multiple pages of drawings within the same file. This makes it convenient for engineers to page through sets of related drawings. Having separate files for 30 or 40 individual drawings becomes cumbersome for effective review.

One limitation of electronic drawing review and approval is monitor size. "The minimum monitor size we recommend is 21 inches," says New York's Rimmer. "You need that size for viewing multiple drawings on the same screen. You can get by with a 17" monitor, but review becomes difficult for large projects. As engineers, we often want to go back and forth among multiple views of related drawings." Dual-screen technology is now an affordable and viable solution. The cost of an internal dual-screen computer video card is about $100.

Rimmer adds that the New York DOT is examining other activities amenable to electronic distribution of documents. "We're looking at bid documents, fabrication-inspection reports, material-testing reports (from steel mills), steel-transportation drawings, and overhead-sign drawings," Rimmer said. "In addition, I'm working on a task force for the National Steel Bridge Alliance that is devoted to web-based document management. We're trying to integrate all the labor-intensive elements of our quality assurance program to bring them to the web, reducing paper, costs, and delays."

New Jersey Interchange Project

The New Jersey DOT recently permitted electronic review and approval of fabricator shop drawings for a new interchange project. According to Tom Zink, project structural engineer for Gannett Fleming Inc., the effort reconfigured the Routes 1/130/171 interchange in North Brunswick Township. This interchange previously consisted of an at-grade signalized intersection used by approximately 200,000 vehicles per day. At the time, this intersection had the state's highest accident rate.

Four steel plate-girder bridges were key to the interchange solution. The project included two five-span bridges, a single-span bridge, and a two-span bridge, all steel. Two of the bridges incorporated complex steel cross girders. The four bridges required a total of 1,861 tons of steel, of which about 40% was high performance steel (Grade HPS70W). High Steel Structures produced 259 shop drawings and fabricated the steel for the project.

With a tight 18-month timetable for full construction, Zink conferred with Don Lee of High Steel Structures on how to speed review and approval of shop drawings. Their solution to use electronic submissions for shop drawings was presented to the New Jersey DOT. The DOT agreed, provided that the final approved shop drawings were submitted as full-sized hard copies. "All of the iterations could be electronic," Zink said. "This saved a substantial amount of time by eliminating the dependency on mail-carrier service."

To keep everyone in the loop, Gannett Fleming hosted a project-specific web site. "Shop drawings and requests for information (RFI) were posted on the web site in Adobe PDF format," Zink said. "The web site also included contact names and numbers, as well as procedural flowcharts and instructions on how to handle the documents.

The web site introduced automated procedures. For example, when an RFI appeared on the website, e-mails would automatically go out to all parties, so work could begin immediately to provide the necessary information. When the RFI response was posted, the web site once again would automatically notify all parties in accordance with a set of predetermined rules.

Because the technique was new, it took the team some time to learn where to find things on the web site. But soon the process went smoothly. "The reviewing engineers would print the PDF drawing files, manually mark them up, and then re-scan them," Zink said. "The alternative was to learn the Acrobat software for editing the PDF files, which was not practical in this case, due to the highly accelerated schedule of the project."

Zink notes that Gannett Fleming instituted a tight verification system of electronic signatures and passwords to ensure that the drawings were reviewed and marked up by the right people. "These systems verify the authenticity of the documents," he said.

To further enhance the speed at which shop drawings were reviewed, partial submissions were permitted. Since the web site kept copies of approved sheets available at all times, cross-referencing of sheets still could take place even though the current submission only contained a few sheets.

"Electronic approval of shop documents was an unqualified success for this project," Zink said. "This centralized flow of information shared among the fabricator, contractor, consultant, and owner proved to be the vital link that kept the steel delivery schedule intact. The New Jersey DOT could keep abreast of project progress without getting bogged down in day-to-day details." ★

Conn Abnee is Executive Director of the National Steel Bridge Alliance in Chicago.

Past issues of *Bridge Crossings* are available at **www.nsbaweb.org**.