Making the Essential Connections on "A Bridge to the 21st Century"

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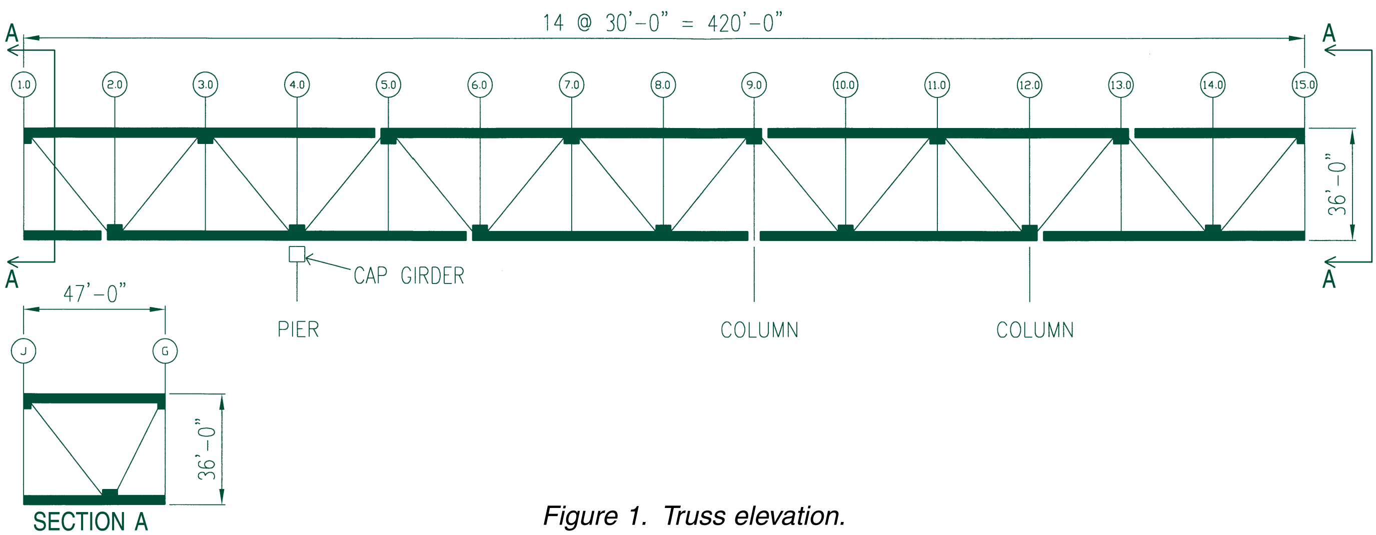

Figure 1. Truss elevation.

Background

The building permit cost $185,000. The field erection consumed 1.1 tons [0.99 tonnes] of welding electrode. In another year, the structure will hold more than 80 million pages of documents, 40 million e-mails, 2 million photographs and almost 80,000 artifacts. When it opens in November 2004, the $160 million William Jefferson Clinton Presidential Center is expected to put Little Rock, Arkansas on the map as a tourist destination. For the employees of AFCO Steel of Little Rock, Arkansas, the company that fabricated the structural steel for the building, the project holds special meaning. According to Bob Bendigo, V.P. of Operations at AFCO, "The people who build our projects in the plant are seldom able to see them go up. But in this case, we all drive by it every day, coming to and from work.

The plan required the steel pieces to fit together perfectly the first time

And that caused a heightened interest in the project, and a pride that went along with that."

The long, slender building elevated above a park was designed by the Polshek Partnership of New York to express former President Clinton's favorite theme for his administration, that it was "a bridge to the 21st century." The oblong design also echoes the six bridges that span the Arkansas River in Little Rock. In addition, Architect James Polshek incorporated an existing (now unused) railroad bridge into the site design; it will be renovated for pedestrian use. The circa 1899 Choctaw railroad station depot building adjacent to the presidential library is being renovated to house the Clinton School for Public Policy, which will grant master's degrees in public services starting in 2004. A 30 acre [120,000 m^2] park featuring an amphitheater, a children's playground, and trails for walking and bicycling, is the site for the entire complex.

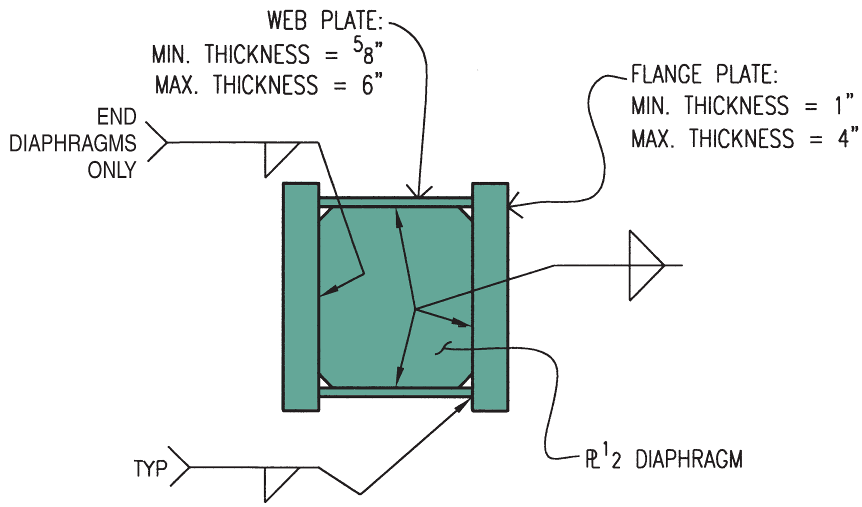

Figure 2. Typical truss member section.

Developing the Game Plan

The library's design called for two large parallel trusses, 420 ft. [128 m] long, and 36 ft. [11m] tall. With supports at only three locations, the two ends of the building were designed to cantilever out 90 ft. [27 m]. On the north end of the building, a massive steel pier supports the structure. This design not only created the architect's vision of a bridge, but also resulted in bridge-like members for the steel fabricator to build.

When AFCO Steel won the contract to fabricate the structural steel for the Clinton library, the company knew that all of its planning would flow from the methodology selected to erect the structure. Proposals were submitted by four erectors, all of whom had comparable qualifications. But according to Gary Johnson, V.P. of Contracts for AFCO, "This job was so unique, no one could say, 'Yeah, I've built some of those before.' So we had as many different schemes to erect this building as we had bids. They were each firmly committed to their own way of erecting the project." In the end, AFCO chose the strategy proposed by Derr Steel Erection Company of Euless, Texas, which called for the truss to be fabricated in individual pieces, then, using falsework, to put the pieces in their proper position and elevation and to assemble the truss in the air, in the vertical position. This scheme modified the normal practice of performing more welding in the shop, versus in the field. And the plan required that the steel pieces would have to fit together perfectly, the first time, if the job schedule was to be maintained.

While the truss design and its assembly on site echoes elements typical of bridge construction (see front and back cover photos), the building of course did not pose the dynamic loading challenges of a bridge. And while bridges are usually field-bolted, this structure would be joined together with field welded connections. Unlike most buildings made principally of wide flange shapes, the library made extensive use of built up, four-plate box sections, fabricated in the shop and requiring very high standards of dimensional control.

Fabricating the Members

The planning for the project had to be meticulous. Every piece of structural steel was custom-fabricated by an AFCO shop crew that numbered from 30 to 40 welders. AFCO's Johnson said the greatest challenge overall was "To maintain the integrity of each piece that we were building, as well as to make the connection preparations that would fit together in the field to complete the truss configuration. Because of their size and weight, we could not lay these trusses down in our shop." To supply the Derr Steel Erection Company with a steady stream of fabricated components in the field, AFCO allowed a 10-week lead time for fabrication of the box sections that would make up the truss chords and braces, and 4-6 weeks for the wide-flange members that were used for floor beams and other members. Johnson noted that at the outset, the planned lead time seemed more than ample, but "in the end, it was just about right. We wouldn't have wanted to do it any faster."

The first truss drawings were issued to the shop on September 3, 2002. Truss fabrication began seven days later and was completed on January 16, 2003. Elements of the complex fabrication task included:

Truss Members

The truss chords consisted of four-plate built-up steel box sections made of A572 Grade 50 and A588 plate. A572 was used for members with thicknesses ranging from 5/8 in. [15 mm] to 4 in. [100 mm], and A588 for thicknesses greater than 4 in., and up to 6 in. [150 mm] (since the A572 Grade 50 specification covers material up to and including 4 in. thick, whereas the A588 specification governs plate up to 8 in. [200 mm] thick). The truss has 30 vertical members, 32 diagonal members, 36 chord segments, and 36 nodes (see Figure 1). The verticals and diagonals were shipped as individual components to be erected at the site. The

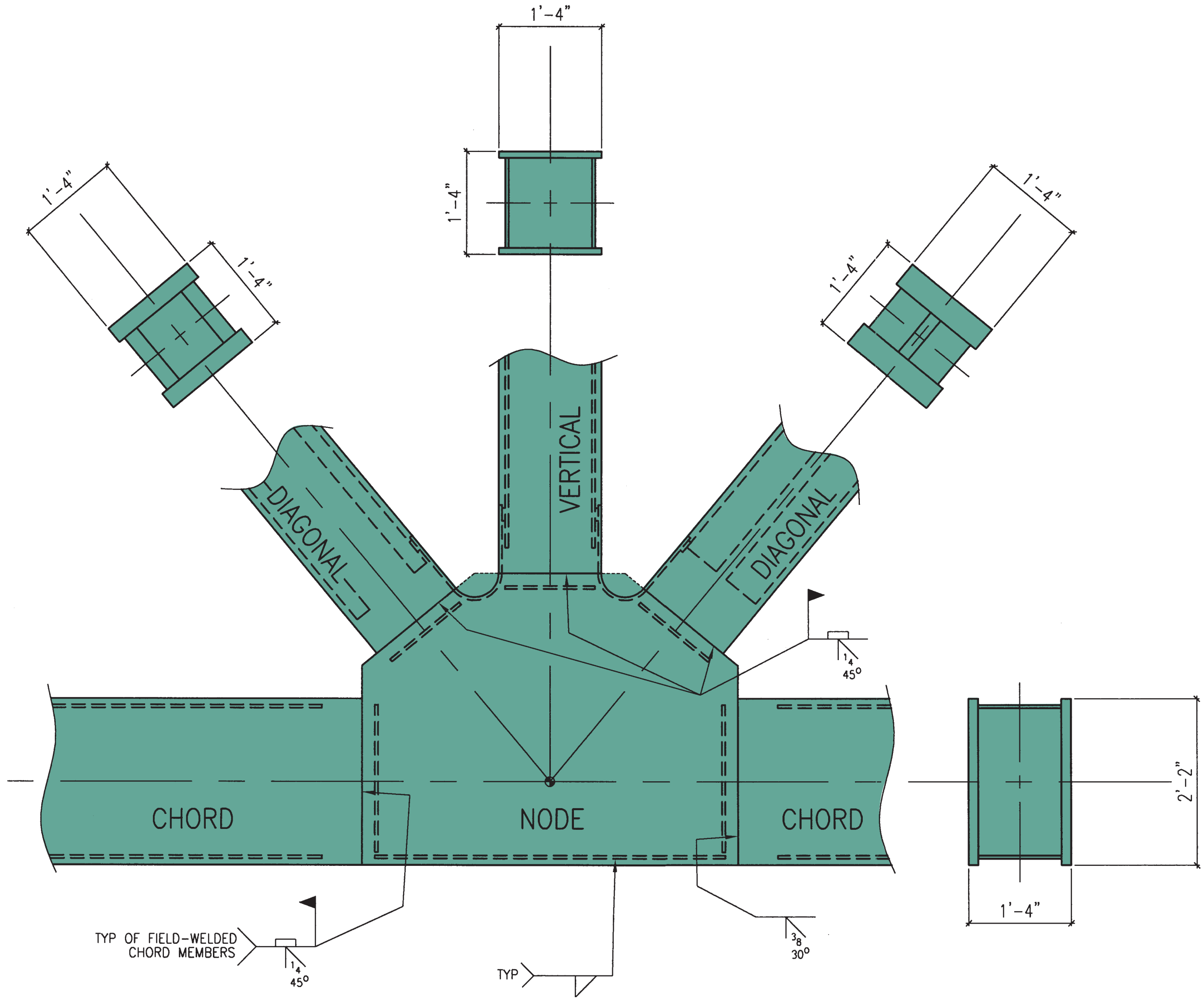

Figure 3. Typical node configuration.

36 nodes and 36 chord sections were shop assembled into 22 shipping pieces ranging in length from 28 to 125 ft. [8.5 to 35 m] long, and weighing up to 40 tons [36 tonnes].

Box Welding

Each four-plate box section required four full-length fillet welds, to fabricate the member (see Figure 2). Fillet welds ranged from 5/16 to 1/2 in. [7 to 13 mm], depending upon the thickness of the plates being joined. The 4,178 linear ft. [1273 m] of box members required 16,712 linear ft. [5,094 m] of shop fillet welding—or a total of 3.2 miles [5.1 km]. Shop welding was performed using submerged arc welding and shielded metal arc welding.

Chord / Vertical / Diagonal to Node Welding

The steel trusses have all welded connections, with the verticals and diagonals connected to the chords at nodes (see Figure 3) using complete joint penetration groove welds in plate varying from 1 to 4 in. [25 to 100 mm] thick. The 36 chords and 36 nodes were shop assembled into shipping pieces using 1,456 in. [37 m] of CJP groove welds. The balance of the welding of the chords/verticals/diagonals to the nodes was completed on site using 6,032 in. [153.2 m] of CJP groove welds field welded in the horizontal and vertical positions. Flux cored arc welding was used in the field.

Support Columns and Piers

The above-grade structure is supported at the center and the south end by four columns that are four-plate built up box sections similar to the truss members. They were fabricated of plate in thicknesses of 1-1/2 to 4 in. [38 to 100 mm], are 41 ft. [12.5 m] long and have an average weight of 12.5 tons [11.34 tonnes]. The north support is a steel pier composed of two columns and two cross members that tie the columns together into a single assembly 36 ft. [11 m] tall by 20 ft. [6m] wide. The 72-ton [65.3 tonne] pier was fabricated outdoors due to its size and weight, then shipped to the site as a single unit. The massive steel pier cap shown in Figure 4, fabricated by Capital Steel in Oklahoma City and trucked to the job site, is 15 ft. [4.6 m] deep by 50 ft. [15.2 m] wide and weighs 95.5 tons [86.6 tonnes].

The Field Erection Process

In the field, the greatest challenges were: supporting the structure with falsework towers and bracing, and minimizing distortion to maintain the straightness of the structure.

According to Jeremy Beadles, project engineer with Derr Steel Erection, the 700 ton [635 tonne] weight of the truss was daunting: "With a truss that heavy, it's really hard to design erection aids that can carry the load."

Carl Williams, senior engineer with Derr, described efforts to maintain the straightness of the structure: "We worked out a sequence of welding both sides of each joint at the same time to minimize the welding draw. Then we went through the structure and came up with an overall welding sequence in order to minimize the possibility of it all drawing the structure out of alignment. Our sequences worked well, and we were able to keep the structure in a whole lot tighter alignment than even the Engineer of Record thought we could." Preheats from 150-350°F [65 to 175°C] were used, with some welders arriving at the site at 5:30 a.m. to start the preheating process, ensuring the required temperature would be achieved when the rest of the welders arrived at 7:00 a.m.

The project was managed by CDI Contractors, LLC of Little Rock, Arkansas, and their project manager, Rob Hawkins.

A "Hold Your Breath" Moment

The four-story, 420 ft. [128 m] long building is supported in just three locations, with the trusses on the north and south both cantilevered out 90 ft. [27 m]. AFCO's Gary Johnson pointed out, "In putting the truss together, we were instructed by the design engineer to cant those end sections upwards 2 in. [50 mm] above true horizontal, from the last support. There was temporary shoring under the truss members to achieve that upward cant. After the truss was fully erected and all the field welds were made, the shoring had to be removed, and the weight of the structure had to be carried by the trusses. There was a predicted drop for the weight of the steel, and a predicted drop for the added weight of the concrete, and a predicted final drop when the wall cladding was added. So we were quite apprehensive to see if we would maintain the proper deflection. It was supposed to deflect about 2 in. [20 mm], and that's what it did. At that point, we knew we had the job in hand."

For those who built the structure, it represents a triumph of meticulous planning and precision

The Topping-Out Ceremony

On May 23, 2003, with over 3,000 people cheering him on, former President Clinton added his signature to a beam already adorned with the names of 5,000 donors to the William J. Clinton Presidential Foundation. It was the final piece of steel to be hoisted into place signifying the completion of the structural phase of the library's construction. The *Arkansas Democrat Gazette* reported that Mr. Clinton told the crowd, "I've lived a highly improbable life. I hope this library and museum will capture a little of that, but in a larger sense." Upon completion of the building, he plans to spend at least one week a month in Little Rock, living in a private apartment on the top floor, and participating in educational programs at the Clinton School of Public Service next door, which will be affiliated with the University of Arkansas.

The Clinton Presidential Center complex (Figure 5) is seen as an economic catalyst for the city of Little Rock, whose mayor, Jim Dailey, told the *Gazette* "New businesses are coming here, and the city is attracting a great deal of attention because of the library." For the engineers, foremen, ironworkers, and fabricators who built the steel structure, it represents not only hometown pride, but a triumph of meticulous planning and precision welding. As Warren Lenon, quality assurance manager for AFCO, said, "The most satisfying thing was just seeing how it welded together. It really went together well."

Figure 4. Cap girder erection on pier.

Figure 5. The William J. Clinton Presidential Center and Park.