AMERICAN CONSULTING ENGINEERS COUNCIL'S

AFFILIATE

HEAVY MOVABLE STRUCTURES, INC.

4TH BIENNIAL SYMPOSIUM

NOVEMBER 10TH - 12TH, 1992

SHERATON DESIGN CENTER
FT. LAUDERDALE, FLORIDA

SESSION
WORKSHOP NOTES

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HNTB
"Rehabilitation of ASB Bridge; Kansas City, Mo."

REHABILITATION OF THE A.S.B. BRIDGE IN KANSAS CITY, MISSOURI

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INTRODUCTION

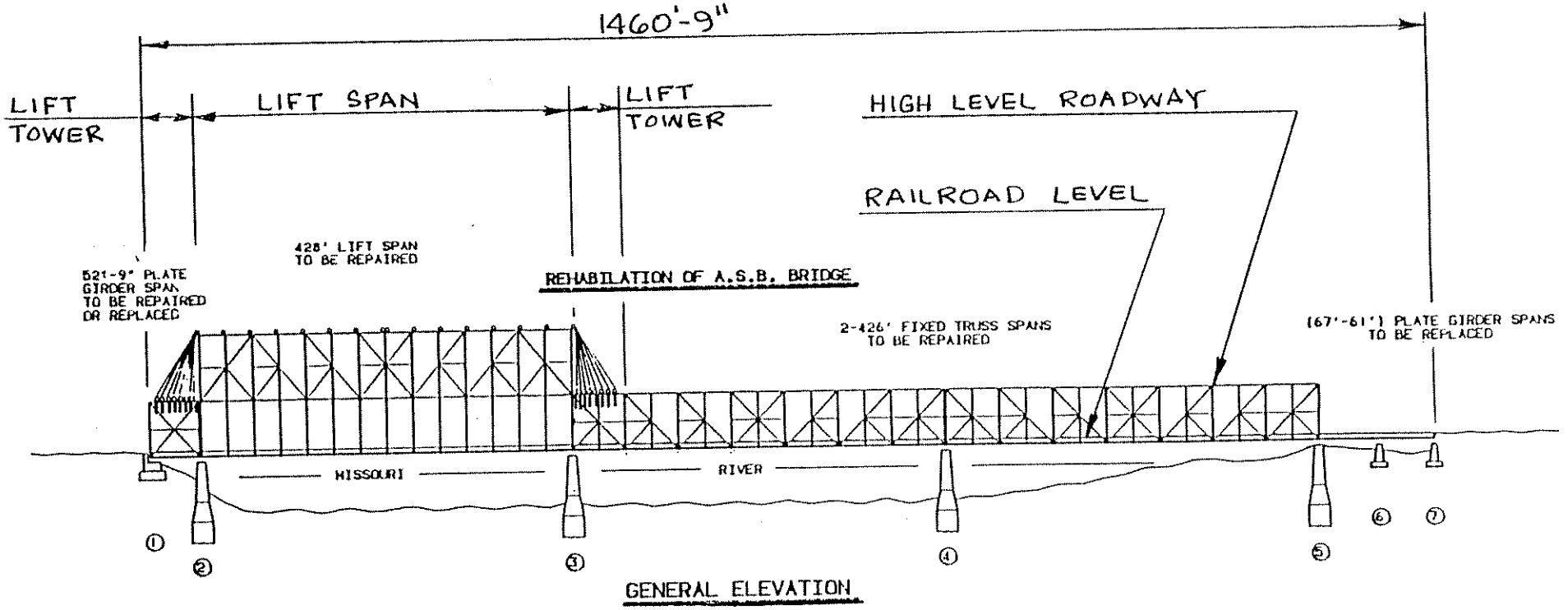
Located in Kansas City, Missouri, across the Missouri River, the A.S.B. Bridge is a two level historic double track railroad movable bridge that is over eighty years old. At one time, the top level carried four lanes of vehicular traffic and the lower level carried two railroad tracks. Today only one railroad track remains in service. The bridge length is 1460'-9" feet and consists of the following spans:

Span 1 - 52'-9" Ft. Deck Plate Girder (DPG)
Span 2 - 428 Ft. Vertical Lift Span
Span 3 - 426 Ft. Through Truss
Span 4 - 426 Ft. Through Truss
Span 5 - 67 Ft. Deck Plate Girder (DPG)
Span 6 - 61 Ft. Deck Plate Girder (DPG)

A schematic layout of the bridge is shown on Figure 1. Figure 2 is a larger scale view of the lifting span and Figure 3 illustrates a typical section through the lifting span.

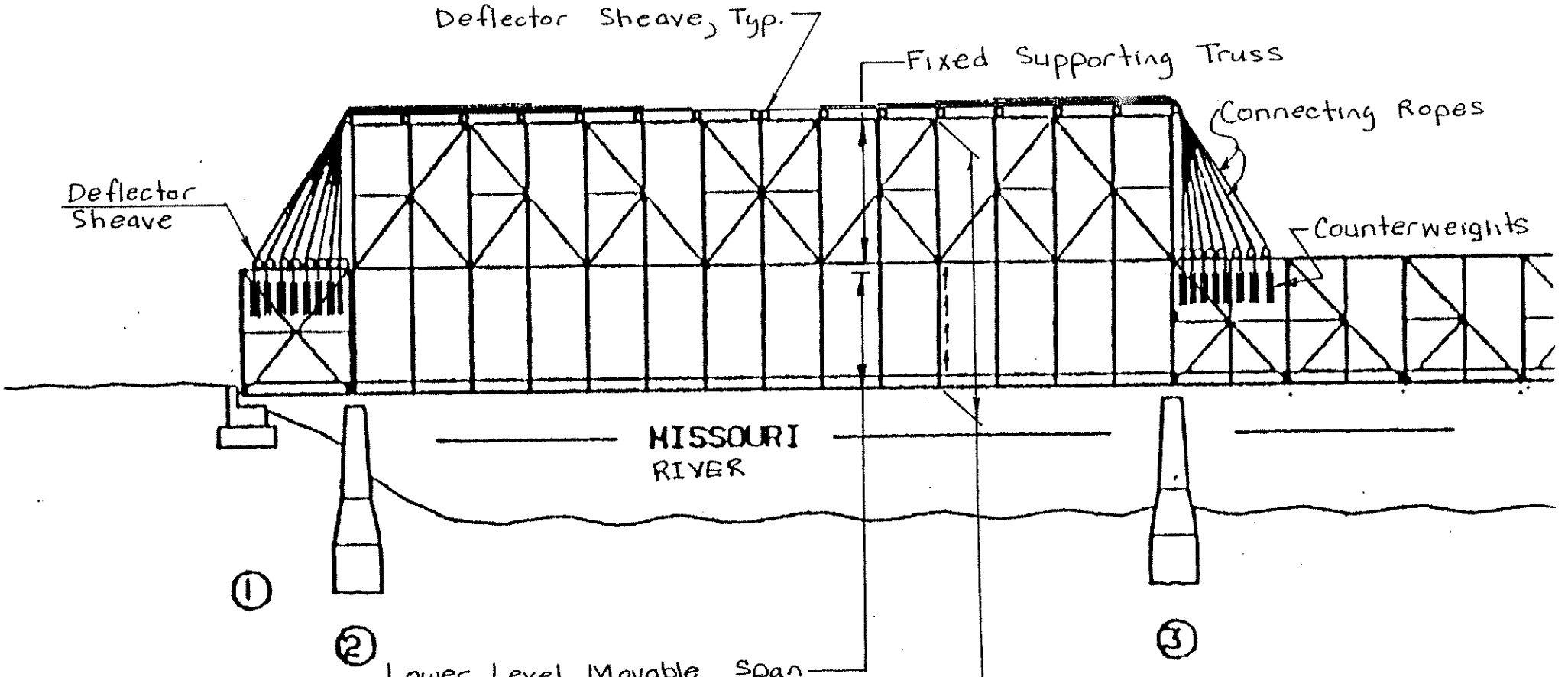
The historical significance is derived from Span 2 which is the movable span. The upper level of Span 2 is a through truss which supports the lower railroad level by utilizing telescoping hangers at each truss panel point. The uniqueness of the structure is that each of the lower level hangers is individually connected to its own independent concrete counterweight. The counterweights are connected to the hangers by means of a steel cable which runs vertically up the overhead truss sleeves, makes a 90 degree bend over a deflector sheave at the top of the truss; then, runs longitudinally across the top of the truss to the master deflector sheave at the corner of the truss where the cable finally extends downward to the counterweight located on the side of the lifting tower. See Figures 2 and 3.

Today the structure has been structurally rehabilitated at a cost of approximately $14 Million. The current owner is the Burlington Northern Railroad. This paper presents a brief history of the bridge and some of the problems associated with the rehabilitation work and how those problems were overcome.



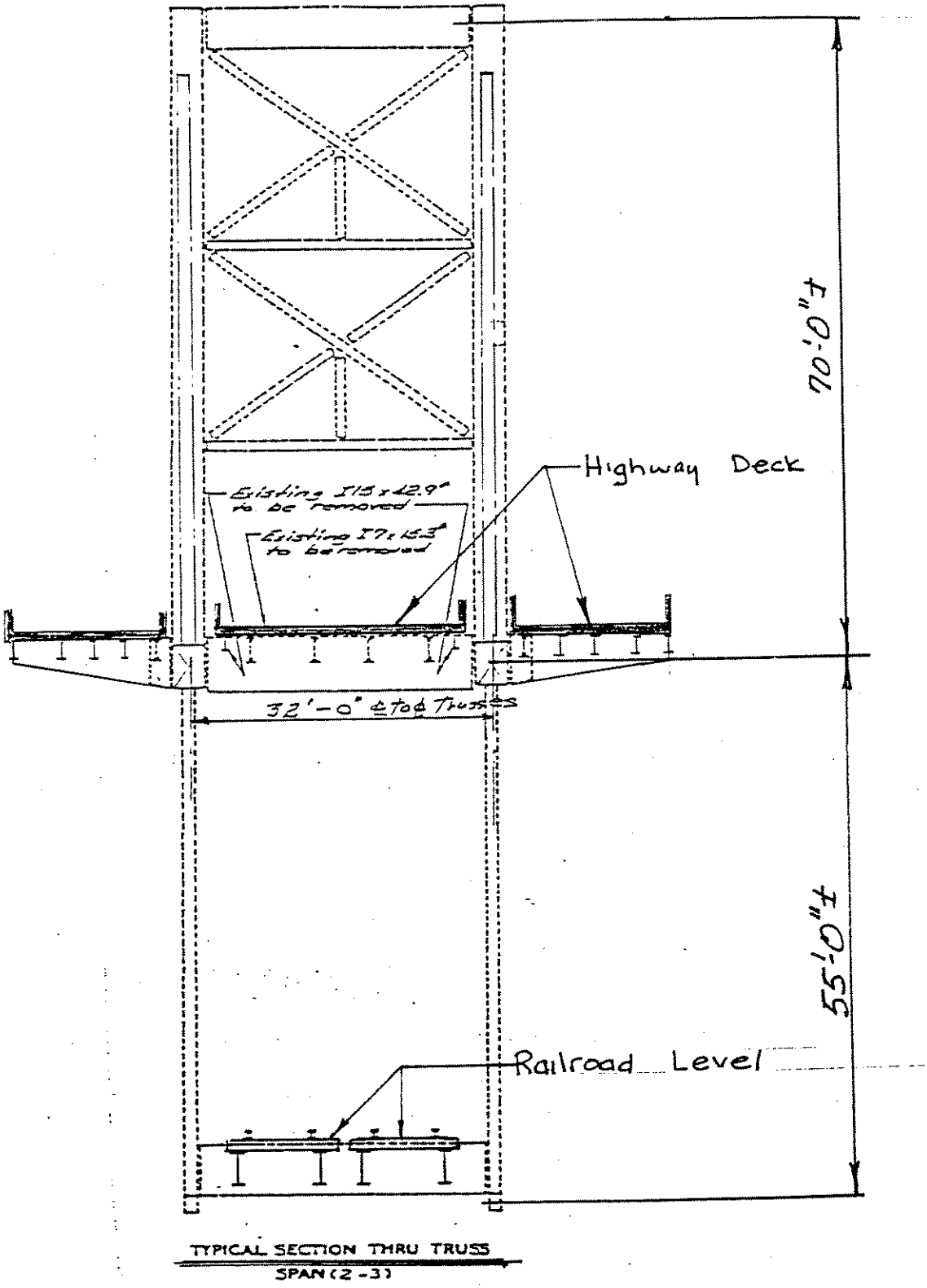
GENERAL ELEVATION

FIGURE 1



ELEVATION - LIFT SPAN

FIGURE 2



TYPICAL SECTION THRU TRUSS
SPAN (2-3)

FIGURE 3

Bridge History

In 1887 Congress authorized the construction of a bridge across the Missouri River at Kansas City, Missouri. Mr. James A. Low Waddell was retained to design the bridge, which at that time was to be a high level, single-track railroad truss bridge with a vehicular roadway cantilevered on each side of the truss. Waddell completed the design and in 1889, construction was started on nine tapered stone masonry piers. Substructure construction was completed in 1890.

Upon completion of the piers and due to lack of additional funding, the control of the bridge passed to the Kansas City Bridge and Terminal Railway Company whose president was Willard Winner. Winner was active in real estate development in the Kansas City area and at that time envisioned economic development on the opposite side of the river in an area that is now North Kansas City. The proposed bridge was part of his plan for economic development and he named the bridge the Winner Bridge.

In 1894, Waddell was again retained, but this time by Mr. Winner, to design a different structure utilizing the existing piers. The new structure was to have two levels. The lower river valley level was to have two railroad tracks with a vertical lifting deck to provide for navigational clearance. The upper level would provide for two electric interurban car tracks and a vehicular deck with sidewalks. The design was completed but due to financial difficulties the bridge was never built and in 1901 Winner lost his holdings through foreclosure of mortgages to the Kansas City and Atlantic Railroad Company.

During the next two years, the bridge property passed through various holdings until two meat packing companies, Armour and Swift, joined forces with the Burlington Railroad and acquired the site and piers in 1903. These firms incorporated under the name of the Union Depot, Bridge, and Terminal Railway Company. It was not until 1907 that F. W. Fratt, then president of the company, approached the newly formed firm of Waddell and Harrington to have them prepare a study and cost-estimate to redesign and construct the Winner Bridge. Mr. Fratt did not like the name of the bridge and renamed the structure the Fratt Bridge.

Redesign was necessary because during the years from 1894 to 1907 many changes had occurred in bridge design due to improved materials and construction practices. Steel had become an accepted structural material and riveted connections replaced the traditional pin connections.

It was also during the latter part of this period that vertical lift bridges began to be used extensively. Waddell had designed and built a major vertical lift bridge, the South Hallstead Bridge in Chicago in 1892. This structure was the first important vertical lift bridge to be constructed in the United States. Waddell patented his design, which prevented other engineers from entering the field during this period.

In the redesign of the Winner Bridge, now called the Fratt Bridge, the advances made in bridge design of the previous years were applied. The structure was designed utilizing steel, and riveted built-up sections were adopted. The movable span operated by telescoping the hangers inside the vertical post of the supporting trusses instead of letting the hangers pass outside the support truss. Concrete was used for counterweights in lieu of cast iron. In

addition, counterweights were placed at the ends of the span instead of at the panel points. The bridge operated from a machinery house at each end of the span and lifting forces were transmitted using wire ropes.

In 1907, the owners decided to proceed with the bridge, but they could not visualize from the drawings the operation of the vertical lift span. A scale working model was made which presented a visual demonstration of the bridge operation. However, the owners were still not satisfied with the demonstration until a committee of experts in the field of Civil and Mechanical Engineering from around the country gave the movable concept their unanimous approval.

Construction began on the bridge in 1909 when four of the previous constructed river piers (present piers 2,3,4, and 5) were cut down to an elevation that was ten feet above the high water mark. This pier retrofit would now accommodate the wider truss spacing of the bridge (which is 32 feet) and also allowed for a two level structure. Waddell who had designed the piers nearly 20 years earlier in 1888, felt his earlier design of the piers was adequate because the lowered piers provided sufficient width to support the new double track truss spans. The bridge was opened to traffic on December 28, 1911 and tolls were charged for use of the upper deck by vehicles, pedestrians and livestock.

Once opened to traffic, the bridge was renamed the A.S.B. Bridge after the three firms (Armour Meat Packing, Swift Meat Packing and Burlington Railroad) that financed the project.

In the early 1950's, the Missouri State Highway Commission took sole ownership of the bridge in order to have the right to rebuild and maintain the upper level highway deck for vehicular traffic. The agreement between the State and the Burlington Railroad indicated the State would be responsible for all bridge maintenance except the rails and ties, and the mechanical and electrical components which operated the movable bridge span.

In 1981 the State of Missouri built a companion bridge across the Missouri River solely for vehicular traffic. As a part of the plan to abandon and remove the high level highway deck on the A.S.B. Bridge and return ownership of the bridge to the Burlington Northern Railroad, the State agreed to rehabilitate and repair the existing structure. The remainder of this paper focuses on the Scope of Work and problems encountered during the twenty-four month rehabilitation of the A.S.B. Bridge.

1. The Contractual Relationships

The Missouri Highway and Transportation Department developed the plans and specifications for rehabilitating the A.S.B. Bridge, and provided the construction resident engineering. Dick Enterprises Inc., of Pittsburgh, Pennsylvania, was the General Contractor. HNTB represented the Burlington Northern Railroad at the construction site. All involved parties were aware that during repair process, additional deteriorated members would be discovered and consequently decisions had to be made very quickly in the field in order to not delay repair work or delay train traffic. Work was performed during train free periods that were four to six hour windows of track time.

2. Job Description and Scope of Work

The work covered under the contract to rehabilitate the A.S.B. Bridge consisted of the following items.

a. Replacement of the sheave girders and counterweights at each end of the lift span.

b. Replacement of two north approach spans and modification of existing bearings and anchor bolts at the South Abutment.

c. Replacement of the deteriorated structural steel members identified on the Missouri Highway and Transportation Department bridge plans and deteriorated steel found during the course of repair and replacement.

d. Replacement of deteriorated rivets.

e. Concrete repairs to Abutment 1 and Pier 2.

f. Removal of a portion of the floorbeams and all the stringers that supported the top level highway deck.

g. Clean and paint the existing and new structural steel.

3. Schedule and Job Specification Requirements

The Notice-to-Proceed was issued on January 16, 1990 and work was to be completed by December 13, 1991.

Material specifications for this job required that all structural steel conform to ASTM A-36 and high strength bolts conform to ASTM A-235. Provisions for impact test requirements of fracture critical plates and installation of high strength bolts were to conform to the AREA specifications. Structural members that were identified in the "Fracture Critical" category were to be fabricated at facilities under the AISI Quality Certification program.

The paint system for the job consists of a three coat Valspar Epoxy Mastic system with the first two coats being alumapoxy followed by a urethane enamel.

The job special provisions required construction to be performed in accordance with the special provisions, the Missouri Standard Specifications for Highway Construction, and the current provisions of the American Railroad Engineering Association, Chapter 15, Steel Structures. In the job special provisions it stated that the "steel construction shall conform to the Missouri Standard Specifications for Highway Construction and AREA, Chapter 15, and in case of conflict, AREA Specifications shall govern." This requirement was requested by the railroad prior to approval of the final plans and specifications.

4. Communications and Field Decisions

Rapid communication and decision making between all parties was an absolute must if the rehabilitation project was going to be successful in the quality of workmanship, time, and cost.

At the beginning of the project the field office was furnished a fax machine in order to send sketches of field changes to the State Bridge Design Section in Jefferson City (120 miles from Kansas City), the steel fabricator located in town, the BNRR and HNTB. This piece of equipment proved to be a time saver by facilitating the decision making and approval process for field changes. During the 24-month duration of the project there were no train delays beyond the allotted work windows provided by the Burlington Northern Railroad.

One of the keys to the success of the project was the confidence each participant had with the other team members with regard to total team cooperation. All parties recognized that due to the nature of rehabilitation work, many field decisions would have to be made immediately in the field in order to keep the project on schedule and not cause any unnecessary train delays or contractor delays. In most instances, decisions were made and work procedures were redefined immediately in the field. In a few instances, when the Scope of Work was significantly impacted, work was rescheduled until the designers could review the field findings. In almost all cases, the fax machine became the project life line for communicating project changes.

Some of the key participants in the rehabilitation process are listed below:

Agency	Responsibility
Missouri Highway and Transportation Department (MHTD)	• Plan Development • Field Inspection • Contract Administration
Burlington Northern Railroad (BNRR)	• New Bridge Owner • Provide track free time • Have full time field representative to make immediate decisions on project change orders.
Howard Needles Tammen & Bergendoff (HNTB)	• Acted as the BNRR's representative in the field
Dick Enterprises, Inc.	• General Contractor
Southwest Steel Fabricators	• Fabricated the new structural steel • Responded to emergency fabrication of materials

5. Plans

The design plans for rehabilitating the A.S.B. Bridge consisted of 81 sheets prepared by Missouri Highway and Transportation Department. The plans were developed after conducting four on-site field inspections and by using the original bridge shop plans. It was understood by the State and the Railroad that not all parts of the bridge had been inspected since access to some areas was prohibited and that additional drawings would be prepared as the repair work was underway.

Southwest Steel Fabricators was selected by the contractor to prepare shop plans for the work using the original set of design plans with revisions being developed in the field. The shop drawings were distributed to the railroad, who in turn distributed them to HNTB for review.

As work progressed, the contractor requested to make his own shop drawings from field measurements and fabricate steel on-site in order to reduce material turn-around-time from the fabrication shop. Although both the railroad and MHTD supported accelerated turn-around-time of fabricated material, they did not wish to lose their decision making input nor the higher level of quality control from a fabricating shop. Consequently, it was agreed that secondary bracing members could be fabricated in the field, but both the State and the BNRR insisted that primary members be fabricated in an approved shop.

6. Inspection: (To Prepare Contract Rehabilitation Plans)

Initial inspection of the bridge to gather inspection data for development of the contract plans was conducted by climbing and utilization of a railroad inspection vehicle. Prior to inspection no significant effort was made to clean the truss joints, which were filled with 80 years of accumulated dirt and heavy deposits of rust. At most of the truss joints the debris was four feet deep which prohibited the inspection of the joints. Consequently, the subsequent design plans indicated that field adjustment would have to be made, once the contractor had cleaned the joint for inspection by the State.

7. Fabrication

As mentioned previously, fabrication of the majority of bridge components was performed by a structural steel fabricator, but the contractor did perform some limited fabrication at a field trailer and on the bridge members themselves using hand held tools.

8. Cleaning

Maintenance of the bridge steel had been minimal for years leaving deep deposits of dirt, bird droppings, corrosion, and loose paint throughout the structure. In addition, de-icing chemicals applied to the upper level roadway deck had caused severe corrosion to many of the steel members including the lower level railroad deck. The horizontal surfaces of the truss members were also pockmarked, rough, and uneven.

The painting contractor's intent was to clean the steel using high pressure water blasting followed up with chipping hammers to remove the heavy deposits of corrosion prior to

painting. The effectiveness of the cleaning process was hampered because the painter's work and ironworker's work overlapped and occasionally additional cleaning work was required.

To illustrate, at times a portion of the structure would be cleaned only to have the ironworkers return to the areas to perform some additional steel work. This structural steel rework, left fabrication residue such as torch slag, drill bit shavings, loose washers, oil and pieces of corroded steel for the painters to clean up. Depending on the temperament of the painters, the area was either recleaned prior to painting or occasionally the painters would paint over the contaminated area. The attitude was that if the area had been cleaned once, then the area was sufficiently clean for all time. This continued to be a problem for the life of the project and was only solved by diligent inspection by the State and HNTB.

9. Painting

The paint system was a Valspar three coat system with the top coat being a urethane protective coating. As previously mentioned, the overlap and conflict of work between the painters and the ironworkers resulted in situations where the ironworkers caused additional painting rework. The biggest problem was that the first two coats of paint were the same color and in their haste to complete the painting work, the painters were "inadvertently overlooking" areas when applying the second coat of paint. When this was discovered after about fourteen days of painting, the contractor did repaint the previous areas, but to ensure that this would not be a continuing problem we requested the painting contractor add some red dye to his first coat of paint. The result was that when the first coat of paint was applied, the bridge was pink in color. For the duration of the project it was easy to tell when the first, second and third coats of paint had been applied.

10. Erection and Materials

Typically, faying surfaces of plates or shapes should be flat, smooth, full sectioned, and clean prior to assembly to insure full development between the two pieces. In several instances on this job, the faying surfaces were rough and coated with rust and in some instances had holes and/or horizontal cleavage planes thru their thickness.

It is acknowledged that it is prohibitively impossible, in time and money, to correct all the deficiencies of the existing structural steel. However, it is felt that the new steel joined to the existing steel with new high strength bolts will extend the life of the bridge for many additional years of satisfactory service.

Structural steel was obtained from a local fabricator in small inventory orders with storage being located in an open yard area under the Heart of America Bridge located immediately downstream of the A.S.B. Bridge. Bolts, nuts, and washers were shipped from a supplier in steel kegs and stored in the same protected yard area. The Heart of America Bridge provided good protection of the inventory so additional protection from the weather was not needed.

The contractor's operating procedure consisted of moving small quantities of steel and bolts onto the A.S.B. Bridge based on the work assignment to be done and depending on the storage space available on the bridge. The procedure was logical and workable, but a couple nuisance problems developed and remained thru-out the job. The principal problem was that

when steel was not installed in the bridge the same day it moved from the storage yard, the workman tracked mud on it, spilled cutting oil on it, or paint was splattered on it. In addition, the painters inadvertently dropped "stray" pieces of structural steel into the river to make space to perform their painting tasks.

Another problem was that open kegs of bolts, nuts, and washers were not protected from the elements after being opened. This allowed a light rust film to develop on some of the fastener items which complicated the tightening of the bolts. The contractor began experiencing problems with getting the bolts tight using the turn-of-the-nut method specified in the contract documents and requested that the bolt tightness be developed using a torque wrench. This request was denied and the contractor was required to use the turn-of-the-nut method for developing the bolt tightness. The problem was solved only by keeping the bolts protected from the weathering elements.

11. Job Cost

The original job bid was approximately $11.7 Million with the cost near the end of the job amounting to approximately $14.6 Million or approximately 24 percent greater than the bid price.

330,920 pounds of new steel was purchased for the plate girders of Spans 1,5, and 6. The estimated bid weight of miscellaneous structural steel for repair was 1,187,450 pounds and the tabulated weight tallied near the end of the job was 1,583,552 pounds or about 33 percent overrun. This increase represented deteriorated steel found during the course of repair and replacement. In addition, approximately 150,000 - 7/8" diameter and 15,000 - 1" diameter high strength fasteners were used for field assembly.

In summary, one can say the historic A.S.B. Bridge is retrofitted for another 80 years of service. The structure now has new flange angles on the floorbeams and stringers. New welded plate girders were installed in Spans 1, 4 and 5 and over 70 percent of the lower lateral system was replaced. The sheave girders and counterweights were replaced and the BNRR adjusted the machinery and refurbished the electrical system concurrently with the contractor's activities. In reviewing the structure deterioration, it was obvious that the de-icing chemicals used on the upper vehicular roadway had been the catalyst in accelerating the structural steel corrosion. Now that the highway deck has been removed there will be no more applications of de-icing salts, which should prolong the life of the bridge. Mr. Waddell would be proud of his newly refurbished bridge.