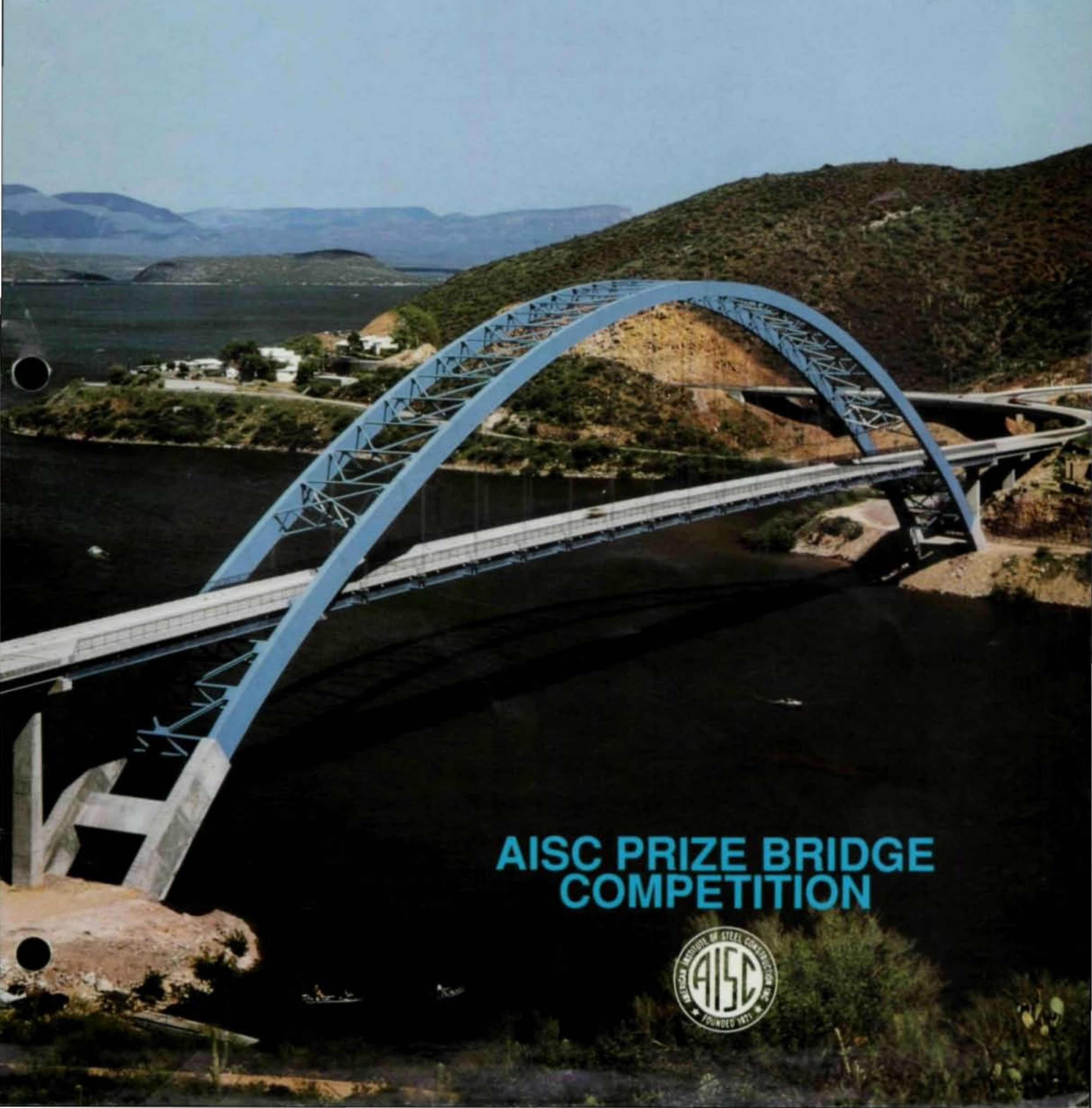
MODERN STEEL CONSTRUCTION

September 1991

$3.00

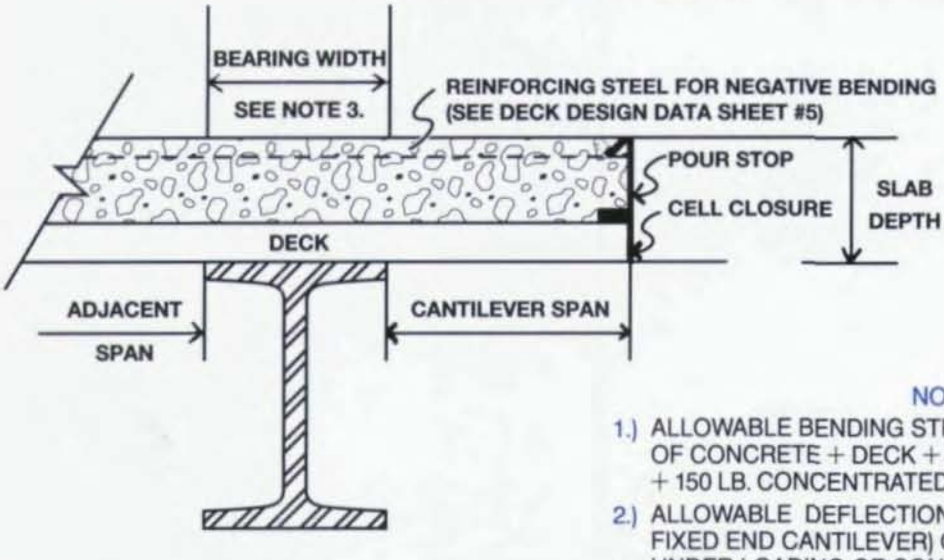


UNITED STEEL DECK, INC. DECK DESIGN DATA SHEET

No. 7

MAXIMUM FLOOR DECK CANTILEVERS

FOR UNITED STEEL DECK, INC.



NOTES:

1.) ALLOWABLE BENDING STRESS OF 20 KSI WITH LOADING OF CONCRETE + DECK + 20 PSF OR CONCRETE + DECK + 150 LB. CONCENTRATED LOAD, WHICHEVER IS WORSE.
2.) ALLOWABLE DEFLECTION OF FREE EDGE (BASED ON FIXED END CANTILEVER) OF 1/120 OF CANTILEVER SPAN UNDER LOADING OF CONCRETE + DECK.
3.) BEARING WIDTH OF 3½" ASSUMED FOR WEB CRIPPLING CHECK — CONCRETE + DECK + 20 PSF OVER CANTILEVER AND ADJACENT SPAN: IF WIDTH IS LESS THAN 3½"; CHECK WITH SUMMIT, NEW JERSEY OFFICE.
4.) CALL NICHOLAS J. BOURAS, INC. ANYTIME YOU NEED DECK INFORMATION.

FLOOR DECK CANTILEVERS

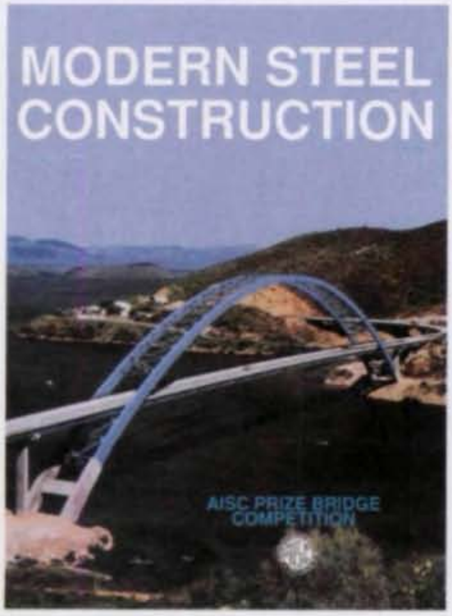
NORMAL WEIGHT CONCRETE (150 PCF)

	UNITED STEEL DECK, INC. DECK PROFILE															
	1.5 IN B-LOK				1.5 IN LOK-FLOOR				2.0 IN LOK-FLOOR				3.0 IN LOK-FLOOR			
Slab Depth	22	20	18	16	22	20	18	16	22	20	18	16	22	20	18	16
4.00"	1' 11"	2' 3"	2' 10"	3' 4"	1' 11"	2' 4"	3' 0"	3' 6"								
4.50"	1' 10"	2' 2"	2' 9"	3' 3"	1' 10"	2' 3"	2' 10"	3' 4"	2' 6"	2' 11"	3' 8"	4' 3"				
5.00"	1' 10"	2' 2"	2' 8"	3' 2"	1' 10"	2' 3"	2' 9"	3' 3"	2' 5"	2' 10"	3' 6"	4' 1"	3' 8"	4' 3"	5' 3"	6' 0"
5.50"	1' 9"	2' 1"	2' 7"	3' 0"	1' 9"	2' 2"	2' 9"	3' 2"	2' 4"	2' 9"	3' 5"	4' 0"	3' 7"	4' 1"	5' 0"	5' 9"
6.00"	1' 9"	2' 0"	2' 6"	2' 11"	1' 9"	2' 1"	2' 8"	3' 1"	2' 3"	2' 8"	3' 4"	3' 10"	3' 5"	3' 11"	4' 10"	5' 7"
6.50"	1' 8"	2' 0"	2' 6"	2' 11"	1' 9"	2' 1"	2' 7"	3' 0"	2' 3"	2' 8"	3' 3"	3' 9"	3' 4"	3' 10"	4' 8"	5' 5"
7.00"	1' 8"	1' 11"	2' 5"	2' 10"	1' 8"	2' 0"	2' 6"	2' 11"	2' 2"	2' 7"	3' 2"	3' 8"	3' 3"	3' 9"	4' 6"	5' 3"
7.50"	1' 8"	1' 11"	2' 4"	2' 9"	1' 8"	2' 0"	2' 6"	2' 10"	2' 2"	2' 6"	3' 1"	3' 7"	3' 2"	3' 8"	4' 5"	5' 1"
8.00"	1' 7"	1' 11"	2' 4"	2' 8"	1' 7"	1' 11"	2' 5"	2' 10"	2' 1"	2' 5"	3' 0"	3' 6"	3' 1"	3' 6"	4' 3"	4' 11"

NICHOLAS J. BOURAS, INC.
P.O. BOX 662, 475 SPRINGFIELD AVE.
SUMMIT, NEW JERSEY 07902-0662 (908) 277-1617

MODERN STEEL CONSTRUCTION

Volume 31, Number 9 September 1991



The Roosevelt Lake Bridge, designed by Howard Needles Tammen & Bergendoff, won a 1991 Prize Bridge Award in the Long Span Category. The story behind the 17 winners in the AISC Prize Bridge Competition begins on page 13.

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False Initiative

A friend was recently raving to me about some of the beautiful old covered bridges she had seen on a recent trip to the East Coast. But why aren't there any new wooden bridges, she wanted to know?

In a nutshell, I answered, they are more expensive than other types of bridges, have more maintenance problems, and may be an environmental hazard.

While specific figures will vary from state to state, it is not uncommon for timber bridges to cost as much as $10/sq. ft. more than comparable steel bridges. And information from the National Bridge Inventory (NBI) shows that timber bridges have the highest percentage of structural deficiency among inventoried bridges.

In addition, the Environmental Protection Agency has determined that coal tar/creosote formations in the wood preservatives used in timber bridges are a risk to human health and that coal tar products are moderately to highly toxic to fish and other aquatic life. And these preservatives are exuded from treated wood for long periods.

While that answer made sense to her, it doesn't seem to satisfy the U.S. Congress. Intensive lobbying by the timber industry is resulting in a tilting of the playing field—at your and my expense. The Timber Bridge Initiative provides federal funds exclusively for timber construction.

In West Virginia, for example, highway officials have reported that several bridges now under construction are only being built from timber due to the availability of federal matching funds.

Some advocates of wood bridges claim they are promoting a "natural" material. But is wood any more natural than iron ore? And while wood is a renewable material, as I've discussed in previous months, steel is one of the few truly recyclable materials.

The true rationale for creating a federal pilot program for timber bridges is to help the timber industry develop the automated routines needed to compete more effectively. While nobody is saying they expect timber bridges to ever be more cost efficient than steel, congressmen from large timber states are hoping that this program will at least help to close the current huge gap. But given the tremendous infrastructure problems in this country, is this really the best use for millions of tax dollars? **SM**

Steel Wins Short-Spa

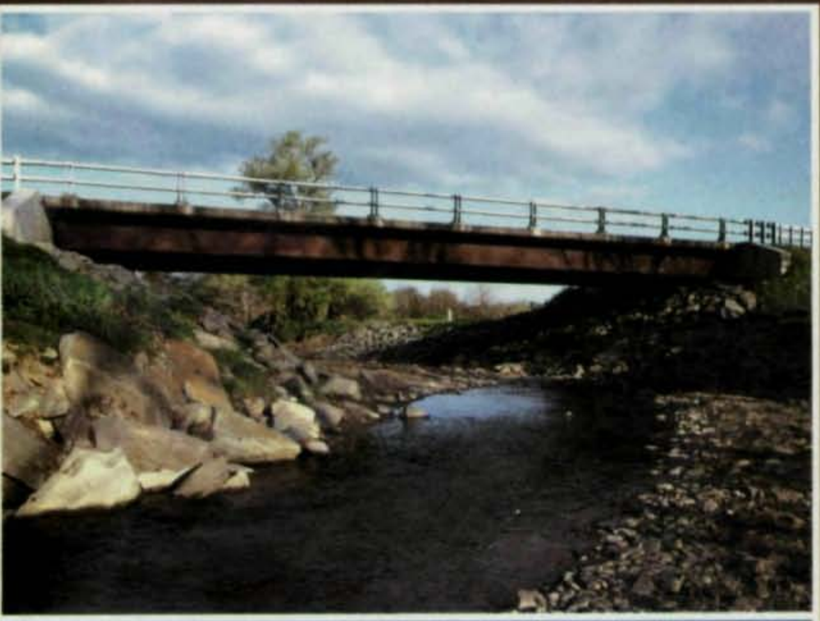
New York State DOT Finds Steel an Economical Solution for Many of Its Short-Span Bridges

The New York State DOT believes in letting each bridge material compete on its own merits. They like to let the marketplace decide which material is most suitable for a particular project when the material choice is not always evident.

That was the situation with the four bridges shown here. In each case, steel competed directly with concrete — and in each case, steel earned the bid.

But it wasn't necessarily the cost of the superstructure alone that made the difference. The DOT prepared complete and independent steel and concrete alternate designs, including foundations. When overall construction costs were compared, steel was found to offer distinct weightsaving advantages that concrete couldn't match . . . like less costly piers

n Bridge Competition



and foundations along with the option to use lighter erection equipment. All of the contractors agreed that consideration of the total construction package resulted in the steel alternates being the low bid.

The use of high-strength weathering steel on each of the bridges also provided benefits in terms of attractive, cost-effective sections compared to conventional steel grades. And because both initial and future maintenance painting are eliminated, savings accrue immediately as well as down the road.

If you haven't considered structural steel for your current or next short-span bridge project, don't you think it's time to give it a try? You may be surprised to find out just how economical steel can be.

We will be happy to send you a report on the four economical steel short-span bridge projects shown above. Just write: American Iron and Steel Institute, 1133 15th Street, N.W., Washington, DC 20005.

Credits:

State Route 7 bridge over Delaware and Hudson Railway, Duanesburg, NY
General Contractor: Schultz Construction Co., Round Lake, NY

Bridge over Page Brook, Chenango Valley State Park, NY
General Contractor: Harrison and Burrows Bridge Constructors, Inc., Glenmont, NY

Route 15 bridges over Mc Clure Creek and Beardsley Creek near Catherine, NY
General Contractor: A.L. Blades Co., Hornell, NY

Steel®

Research Council On Structural Connection
Education Committee

Recommendations For Purchasing, Receiving And Storing A325 and A490 Bolts

The steel fabricator normally bears cost of the high strength fasteners on a project. "Purchase price" and "Delivery" are the main criteria used in purchasing; however, purchase price is the true measure of cost to the fabricator only if the bolt manufacturers and vendors can be counted upon to fully comply with the purchase specifications. Unfortunately with some manufacturers and vendors, knowledge and attention to specification requirements, proper manufacturing and testing procedures and quality control have been neglected disregarded to meet tough competition.

Therefore, carefully prepared purchase orders which clearly and completely specify requirements for manufacture, testing, delivery and storing of high-strength bolts are essential to keep the fabricator's true costs under control while assuring proper fastener performance.

PURCHASING REQUIREMENTS

The purchase order for all ASTM A325 and A490 high-strength bolts must include the following:

(1) The ASTM grade, A325 or A490.

(2) The type, Type 1, 2 or 3.

(3) A copy of the project specification for the manufacturer and vendor.

(4) "Ordering information" as required by ASTM 1990, Volume 15.08 **Fasteners**, Pages 56 and 98.

EVIDENCE OF CONFORMITY

Additionally the purchase order should require:

(1) The vendor to provide certification and the bolts, nuts and washers furnished conform to all requirements of the referenced ASTM specification.

(2) That certified manufacturer's mill test reports be supplied which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

(3) That the bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type as specified by ASTM specifications.

(4) That, for projects which require slip-critical connections, the lubricated bolt, nut and washer be preassembled to assure proper fit of the bolt and nut and the assembly tested for strength to meet the requirements of Table 4, of the *Specification for Structural Joints Using ASTM A325 or A490 Bolts* prior to shipment to the purchaser.

RECEIPT AND VERIFICATION

For acceptance, assure the delivered fasteners comply with purchase requirements verify upon receipt:

(1) That bolts and nut and marked as specified.

(2) That manufacturer's mill test report reflect that the chemistry of the fasteners supplied comply with requirements for the type bolts and nuts specified.

(3) That certification numbers appear on the product containers and correspond to the certification numbers on the mill test reports for the fastener.

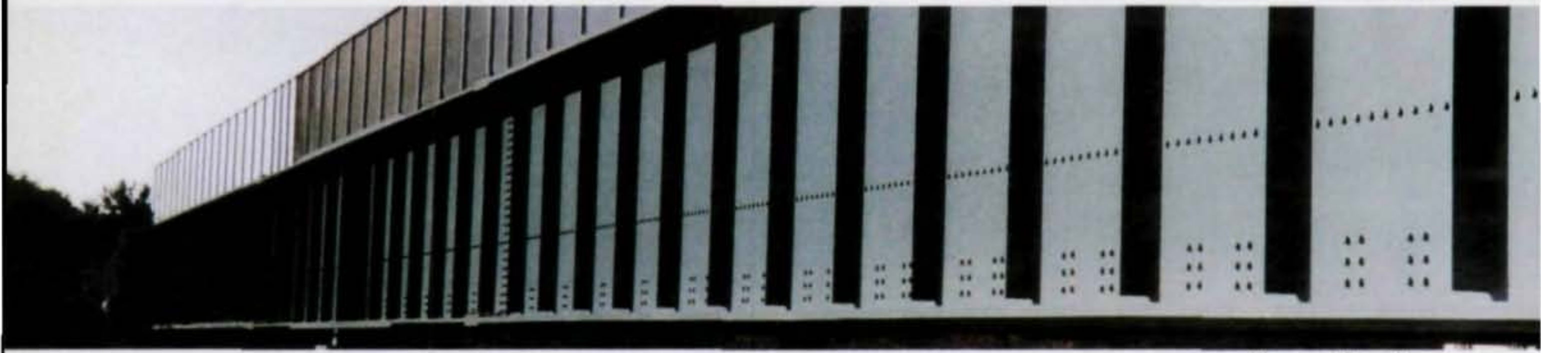
(4) That mill test reports are supplied to both the purchaser and the testing laboratory responsible for quality control.

A representative of the fastener supplier should be present. The inspector shall be present and a tension measuring device shall be available in the shop and at the jobsite at the beginning of bolting start-up. Tests of representative samples of the fasteners received shall be conducted to confirm that the fastener assemblies, including lubrication if required, when tensioned by tightening the nut on the bolt, satisfy the installed tension requirements of Table 4.

STORAGE

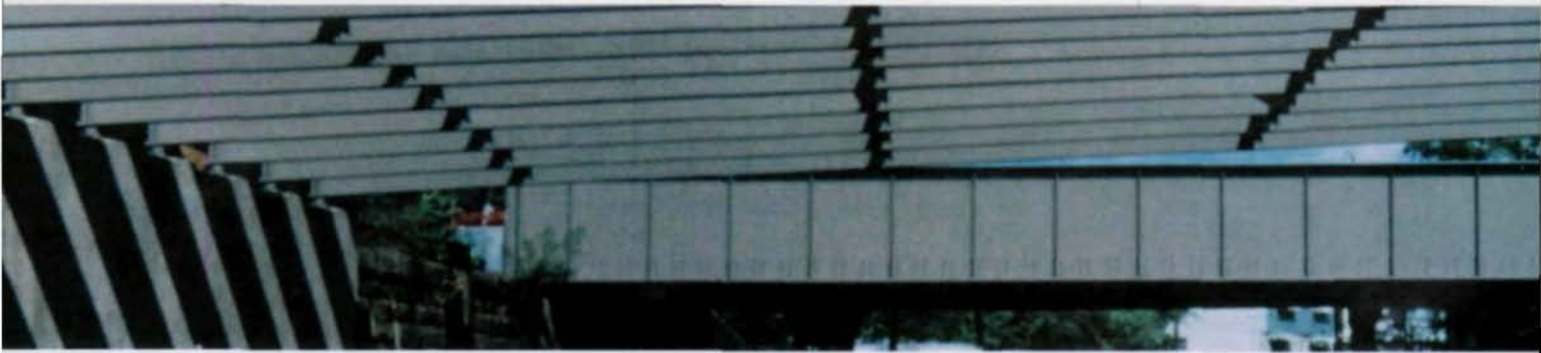
All fastener components shall be stored in a manner that affords complete protection from moisture, heat and dirt contamination. These precautions are necessary to avoid corrosion, loss of effectiveness of the lubricant and dirt contamination which will increase the needed torque and preload scatter ranges. Each day, upon removal from storage, each bucket of fasteners will be visually inspected for corrosion, contamination with dirt and condition of the lubricant. Any fastener found to be corroded, dirty or lacking the coating of lubricant present when delivered to the job site will be deemed unacceptable for installation.

Concrete



Three-coat Paint System

Weathering Steel



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We have to agree. A single coat of gray IC 531 zinc silicate isn't exactly an eye catcher. But then isn't beauty in the eye of the beholder? If bridge maintenance is your headache, you will find that the real beauty of high-ratio IC 531 is below the surface — because IC 531 is a chemically bonded permanent steel treatment.

IC 531 isn't paint or just galvanic protection but rather a combination of high-ratio liquid glass and pure zinc that chemically bonds to the steel and seals off to become a permanent barrier to moisture, oxygen, deicing salts and ultra-violet rays. Should an area become damaged, IC 531 is easily repaired with itself — inexpensively, without blasting and for as long as you care to preserve your steel.

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AISC Prize Bridge Competition

Pictured, from left to right: David Billington, Arun M. Shirole, Robert Flory, Charles Roeder, and Donald Flemming.

From more than 130 entries to the 1991 AISC Prize Bridge Competition, a jury of five bridge experts awarded eight Prize Bridge Awards and nine Awards of Merit.

The winners ranged from a small pedestrian walkway in a Chicago suburb to a 1,000'-long bridge over mountainous terrain near Phoenix to the renovation of a post-World War II bridge spanning the Mississippi River. Descriptions and photographs of all 17 winners are included in the pages that follow.

The members of this year's jury were:

- David Billington, P.E., Professor of Civil Engineering and Director of the Program in Architecture and Engineering, Princeton University, Princeton, NJ.
- Donald J. Flemming, P.E., Minnesota State Bridge Engineer, St. Paul, MN.
- Robert C. Flory, P.E., Chairman and C.E.O., Booker Associates, St. Louis, MO.
- Charles W. Roeder, Chairman, Steel Bridge Research Board of the National Research Council, Seattle, WA.
- Arun M. Shirole, P.E., Director of Structures & Deputy Chief Engineer of the New York Department of Transportation, Albany, NY.

The winning Prize Bridge designers will be honored at an awards banquet at the National Symposium on Steel Bridge Construction in St. Louis on September 16. (For more information on the symposium, contact: Lewis Brunner at (312) 670-5420 Fax: (312) 670-5403.)

The following AISC members fabricated a winning bridge: The Bratton Corp.; Standard Structural Steel; Stupp Bros. Bridge & Iron Co.; High Steel Structures; Carolina Steel Corp.; Harris Structural Steel; Munster Steel; Phoenix Steel; Pitt-DesMoines, Inc.; Sheffield Steel Products; and Vincennes Steel Corp.

AISC Prize Bridge Award:

Long Span

Roosevelt Lake Bridge, Roosevelt Lake, Arizona

When the Arizona Department of Transportation was considering the design for the Roosevelt Lake Bridge in the east central part of the state, they needed to consider more than just economics. The bridge spans more than 1,000' over one of the state's premier fishing spots located just a 125 mile drive from Phoenix, so of course aesthetics played a large role.

The challenge for the designers was to design a two-lane structure that would span more than 1,000', meet stability requirements and be economical. Two consultants prepared complete construction documents on three steel alternates and one concrete design.

When bids were returned, the cable-stayed concrete design was quickly eliminated due to its high cost—approximately $6 million more than the accepted steel bid. The winning bid, a steel box-rib arch, was selected not only because it was the low cost alternate, but because of the arch's inherent ability to adapt to the curved site alignment and its superior aerodynamic properties.

The twisting alignment of the bridge due to mountainous terrain made it difficult to get a tangent alignment long enough for alternate structure types, explained Gray C. Wangelin, P.E., structure

group manager in Howard Needles Tammen & Bergendoff's Phoenix office. The arch span, however, does not require straight approach spans.

The bridge consists of 42 major A572 steel arch rib sections. The arch rib was designed to minimize material through the length of the rib, and each steel arch rib is made up of two 4'-wide flanges with two web plates that vary from 8' at the crown to 14' at the baseplate. Plate thicknesses vary from 1-7/16" at the crown to 2" at the base connection.

To prevent buckling, the rib box sections are stiffened longitudinally and the webs of the box sections are stiffened internally by two tee sections welded to each web. The tee sections are made continuous through the rib field splices and participate fully in carrying the various loads.

Box rib sections were fabricated in lengths of 40' to 58' and weigh from 40 to 100 tons apiece. Fabrication and material costs were reduced by using closed steel box sections for the arch ribs rather than open steel sections.

The stability of the arch against wind loads and global buckling was achieved through a diagonal-bracing system fabricated from structural tubing and welded box sections. Vierendeel bracing also was considered, but the diagonal-bracing creates a much stiffer structure.

"The Vierendeel design would have allowed 24" of sidesway movement, while the diagonal-bracing allowed only 12" of sidesway movement from wind load," Wangelin said. Aerodynamic considerations were very important on this project due to the height of the arch, the narrow 50′ rib spacing, and the high-velocity mountain winds.

Another advantage of diagonal bracing is that it required 200 less tons of steel than would the Vierendeel design.

Aesthetics also played a role in choosing a bracing system. "The Vierendeel bracing was more massive, it looked like you were driving under a ladder. The way it is designed now creates a very light and airy look," Wangelin added. "The geometric shape of the arch was modified by increasing the arch curvature below the approach span level. This reduced the dead load bending stress on the arch rib from approach span loads. The resultant shape is defined by both second and fourth order curves that make the entire arch appear smooth and continuous."

In fact, the design was so successful that the *Phoenix Republic* recently described it as the state's most spectacular bridge.

Two design elements directly reduced bridge and lifecycle costs. First, closed steel sections were used in the arch ribs and bracing system to minimize corrosion caused by entrapped water and debris. And second, access holes in the arch rib internal diaphragms were created to permit inspection of the length of the arch. □

Roosevelt Lake Bridge

Completion Date:
Oct. 1990
Span Lengths: 1,080′
Roadway Widths: 38′
Steel Wt./Sq. Ft. of Deck:
145 lb./sq. ft.
Steel Tonnage: 3,175 tons
Total Cost:
$19,000,000
Design Firm:
Howard Needles Tammen& Bergendoff, Phoenix, AZ
General Contracting Firm:
Edward Kraemer & Sons, Plain, WI
AISC Member Fabricator (ribs):
Pitt-Des Moines, Des Moines, IA
Steel Erector:
J F Beasley Construction Co., Dallas, TX
Owner:
Arizona DOT

AISC Prize Bridge Award

Medium Span, Low Clearance

Ramp B - Turkey Lake Road Over I-4, Orlando, Florida

As the number of tourists heading to Sea World increased, the existing roadways became more and more crowded. While public agencies recognized the need, they lacked the funds to do anything about it. Fortunately, Sea World's owner, Harcourt Brace Jovanovich Land Company (now Busch Properties of Florida, Inc.) was willing to fund the needed improvements.

Although a private owner was building the roadway, it still had to meet certain conditions. Most notable was the need to minimize disruption on I-4, but also important was the requirement that the new roadway allow enough room to accommodate a future expansion of I-4.

Various steel and concrete alternates were considered, including steel plate girders, steel box girders, and concrete box girders. Erection requirements and cost considerations mandated the choice of a steel box girder structure.

"The major problem we had to overcome was going over I-4," explained Rudy McLellan, P.E., assistant department manager of the structure's department for the Baton Rouge office of Howard, Needles, Tammen & Bergendoff. "But shutting down I-4 completely was not feasible." HNTB's Baton Rouge office provided the structural design for the project and its Orlando office did the geometry for the bridge and highway and designed the abutments.

Because of the need to minimize disruption, the plate girder alternative was rejected in favor of a steel box girder design. "Plate girders tend to have more pieces, which mean a more complicated erection," McLellan said. "You also need more bracing to support plate girders, and that's not as visually attractive." Likewise, a concrete structure also would have interfered more with I-4 than would a steel structure.

Since the bridge had to go over I-4, clearance was crucial, so the designers chose to use integral pier caps. "The ramp would have needed a higher elevation without the integral pier caps. We probably would have had to raise the whole structure by 6' to 10', which would have added to the cost of the approach and the bridge." And with integral pier caps, a steel box girder structure was less expensive than either a concrete box girder bridge or a steel girder bridge.

Bridge Structure

The final design consists of twin

steel trapezoidal box girders framed directly into pier caps. The bridge has eight spans totaling 1,247', with a 19.5' clearance over four of the spans to allow for a future expansion of I-4. Span lengths range from 105' to 186', with pier heights as low as 23' and as high as 41'. Roadway width is 27'.

Another advantage of a box girder structure is its clean, attractive appearance. The bridge's geometry gives the flyover structure low lines and a sleekness as it curves its way to grade level. And reflecting its source of financing, the steel was painted "Sea World Blue". □

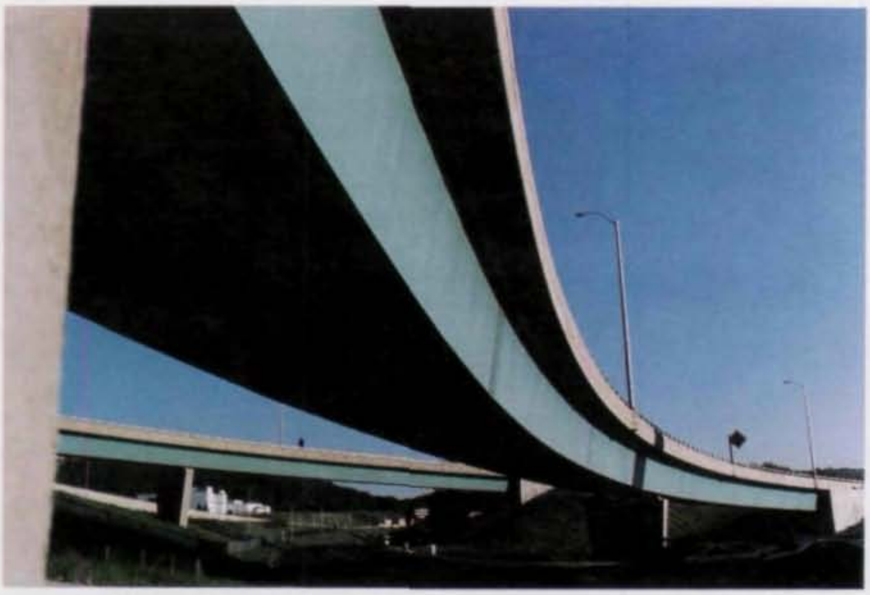
Ramp B — Turkey Lake Road Over I-4

Completion Date:
August 14, 1990
Span Lengths:
1,247' overall;
105' to 186'-6"
Roadway Widths:
27'
Steel Wt./Sq. Ft. of Deck:
49.4 lbs./sq. ft.
Steel Tonnage:
918 tons
Total Cost:
$4,600,000
Design Firm:
Howard Needles Tammen & Bergendoff, Orlando, FL
General Contracting Firm:
Leware Constr. Co., Leesburg, FL
AISC Member Fabricator:
Sheffield Steel Products, Division of Vincennes Steel Corp., Palatka, FL
Steel Erector:
Leware Const. Co.
Owner:
Busch Properties of Florida

AISC Award of Merit

Medium Span, Low Clearance

Ramp X Roadway and Ramp R Roadway, Danbury, Connecticut



Ramp X Roadway & Ramp R Roadway

Completion Date:
October 1986
Span Lengths:
Ramp X: 210', 210'
Ramp R: 175',235'
Roadway Widths:
24'
Steel Tonnage:
Ramp X: 697 tons
Ramp R: 705 tons
Total Cost:
Ramp X: $2,125,000
Ramp R: $2,178,000

Design Firm:
STV/Seelye Stevenson Value & Knecht, Stratford, CT
General Contracting Firm:
D'Addario Industries, Bridgeport, CT
AISC Member Fabricator and Erector:
The Standard Structural Steel Co., Newington, CT
Owner:
Connecticut DOT

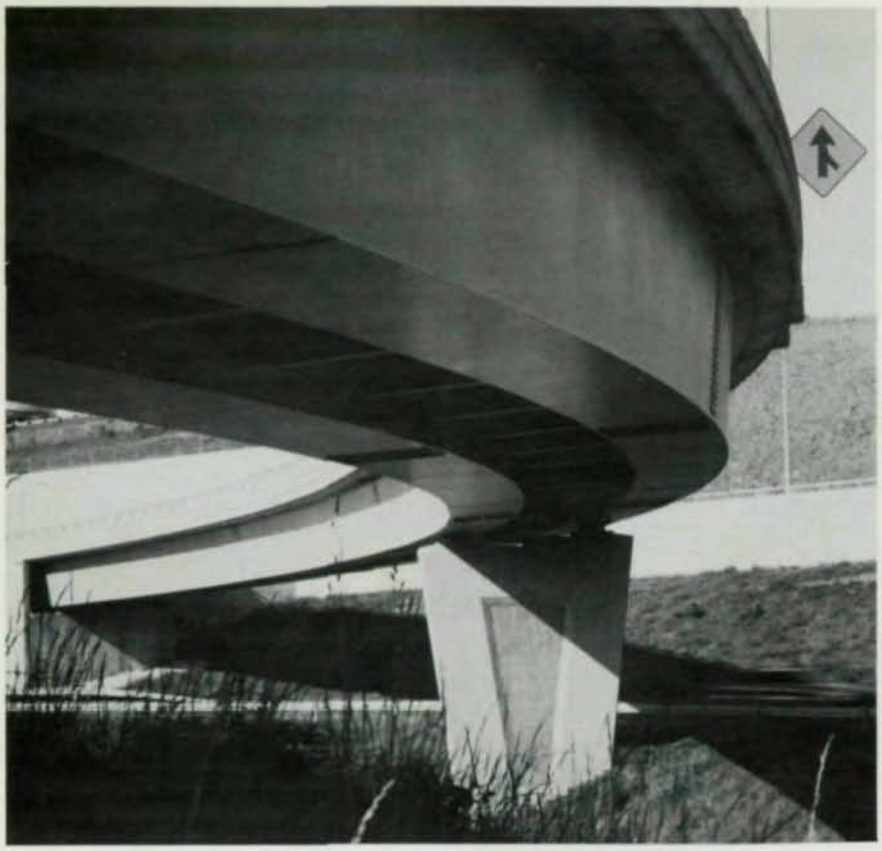
Because of a steep side slope, limited right-of-way and the desire for a high degree of channelization at the ramp terminals, the design for a new interchange connecting the new Danbury (CT) Fair Mall with U.S. Route 7 concentrated ramp development in one quadrant. In addition, the location of a parallel frontage road in the same quadrant as the interchange required two roadway levels and two structures, one spanning double roadways.

The loop ramp consists of high-speed acceleration/deceleration lanes connecting to low-speed ramps. In developing the desired loop configuration, a combination of sharp horizontal curves was necessary for smooth speed change based on the design speed and an acceptable rate of superelevation.

The span arrangement for the outer loop bridge (Ramp X) was determined by the required horizontal clearance for the two roadways under the bridge. This configuration resulted in two equal spans of 210' along a 450' radius. The total structure length between abutments is 420'.

The inner loop bridge (Ramp R) required a 235' span over a single roadway under the bridge. Since it was necessary to maintain an open area under the bridge for access to an adjoining business a second span was required. The final bridge configuration resulted in two unequal spans of 175' and 235' along a compound curve with a minimum radius of 445'. The total structure length between abutments is 410'.

Since the ramps each accommodate a single lane of traffic, the



widths were relatively narrow. Each superstructure was analyzed on a digital computer as a two dimensional grid by the direct-stiffness method. With a middle-ordinate (distance from curve mid-point to chord mid-point) of 12', uplift at the supports was a problem that required substantial torsional rigidity to overcome. Since the ramp geometry was established, the girder length to width ratio—normally reduced to eliminate uplift—could not change. The solution was to increase torsional rigidity by effectively proportioning the external diaphragm size and spacing until uplift under all loading conditions was eliminated.

Two concentrically placed curved steel box girders were selected for a new interchange because of their superior torsional rigidity. "The use of concrete to provide the torsional rigidity was precluded by the limited allowable depth of construction and the need to maintain traffic beneath the structure," explained Robert Gubala, Ph.D., P.E., chief engineer with the Connecticut Department of Transportation. Also, because of the plan view of the loop alignments, steel box girders could be readily designed and fabricated to fit the required curvature of these roadways, which streamlined the parapets and deck work while creating an attractive appearance.

Rigid diaphragms 72" deep and 14' on center were provided between box girders to distribute shearing forces throughout the grid system.

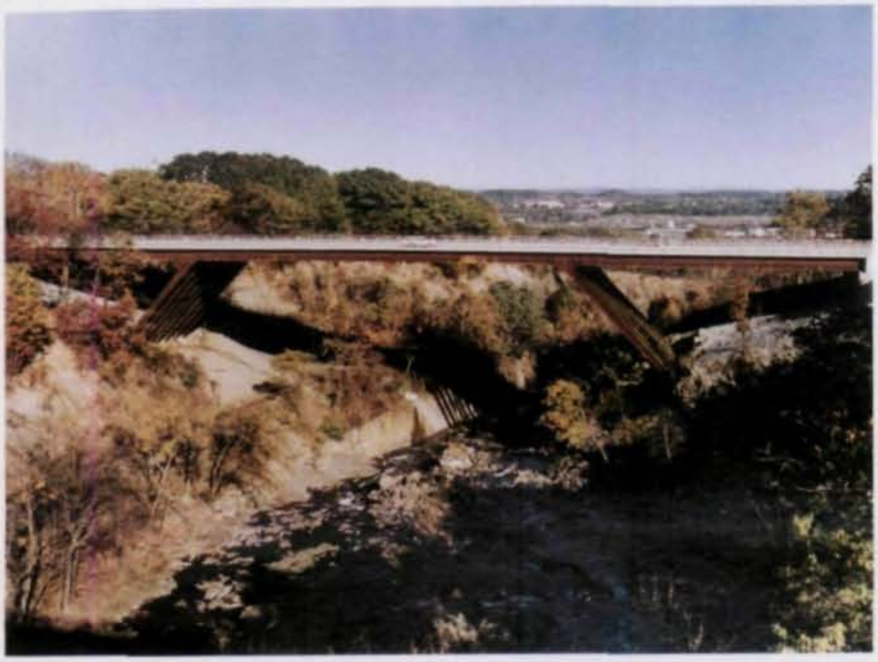
The top and bottom flanges of the box girders were fabricated parallel to the roadway superelevation. Inclining web plates to the same angle relative to the flanges resulted in uniform 90" web plates, simplifying details and fabrication. The project consists of ASTM A588 steel with both a painted shop coat and a field painted finish coat. The A588 steel was chosen because studies have demonstrated an improved paint performance with that type of material.

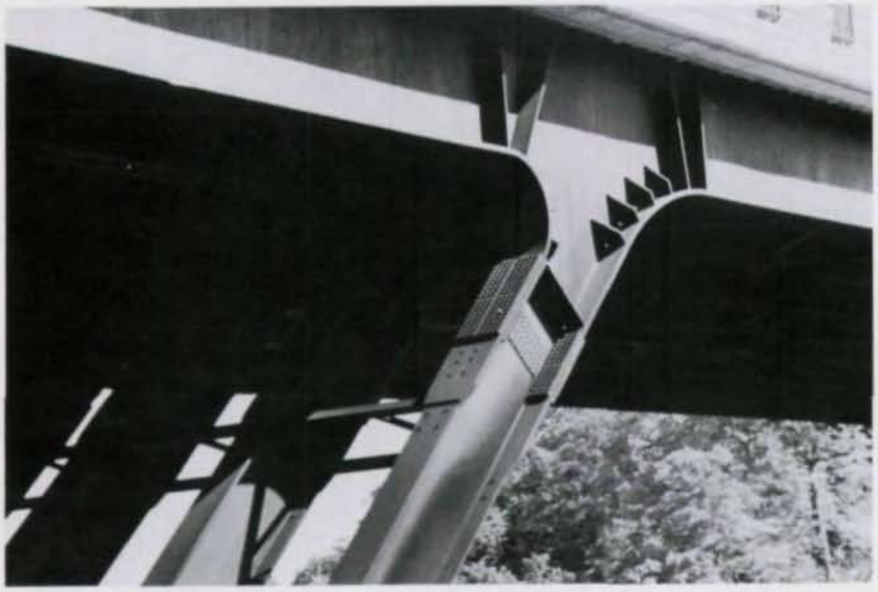
The structure were designed for standard AASHTO HS-20 truck and lane loadings according to Allowable Stress guide specifications. □

AISC Award of Merit

Medium Span, High Clearance

Southern Boulevard Route 9W Bridge over Normanskill, Albany, New York





Located 120' above the Normanskill Gorge, this three span continuous multi-plate steel girder bridge has slanted steel legs instead of more conventional reinforced concrete piers.

"We didn't want to put the piers in the middle of the creek because of a potential erosion problem with the footings," explained Ayaz H. Malik, P.E., an associate engineer (structures) with the New York State Department of Transportation.

In addition, conventional 110'-high reinforced concrete piers would have cost $800,000 more than the steel legs, which were slanted at a 45 degree angle.

The end spans of the bridge are supported by guided expansion pot bearings, allowing free rotation and longitudinal movement of superstructure at the abutments. A uniform, smooth change in the direction of the axial forces from the main longitudinal girders to the slanted legs is provided by means of a curved knee (haunch). The bridge is 71' wide with four 12'-wide travel lanes, two 8'-wide shoulders and a 4'-wide median.

The structure is indeterminate to the third degree due to the interaction of the longitudinal girder with the inclined leg. The bridge is designed for AASHTO HS20-44 loads using working stress method.

Spacious Design

"The slant-legged structure is pleasing in outline, gives the feeling of openness, and is aesthetically appealing," according to J.M.

Robb, P.E., assistant deputy chief engineer (structures) for NYSDOT. "From abutment to abutment, the proportions of this structure are a perfect fit for the surrounding terrain. The elements of symmetry are fully utilized, demonstrating an appreciation for ratio and scale."

The bridge was built with unpainted weathering steel, both for its rugged appearance and the long-term cost advantages. □

Southern Boulevard, Route 9W Bridge Over Normanskill

Completion Date:
November, 1986
Span Lengths:
135'; 200' and 135'
Roadway Widths:
71'
Steel Tonnage:
1,100 tons
Total Cost:
$5,500,000
Design Firm:
New York State Department of Transportation, Albany, NY
General Contracting Firm:
Lange-Finn Construction, Inc., Albany, NY
AISC Member Fabricator:
High Steel Structures, Lancaster, PA
Steel Erecting Firm:
Syracuse Rigging, Syracuse, NY
Owner:
New York State Department of Transportation

AISC Award of Merit

Medium Span, High Clearance

McCarran Boulevard Bridge, Reno, Nevada

As Reno, NV, continues its phenomenal population growth, its infrastructure must grow along with it. However, Nevada's rugged but beautiful terrain place's special restrictions on these projects.

In 1986, Reno's Regional Transportation Commission (RTC) cleared the way for an extension of the west arc of McCarran Boulevard. Though only 4/10 of a mile, it included a 539'-long bridge crossing the SPTC dual main line railroad tracks, the Truckee River, and an open flume water canal. Complicating the design was that Highway 80 cuts across McCarran at a nearly 90 degree angle and atop a 40'-high bluff at the north end of the bridge.

Because the structure would be readily visible from both the highly traveled Highway 80 and a proposed new residential development, the RTC specified that aesthetics were their prime concern—but that the bridge still had to meet a tight construction budget.

Alternates Rejected

Several structural forms were considered but were eliminated because of cost or difficulty of construction, according to Charles Seim, P.E., a senior principal with the San Francisco office of T.Y. Lin International. "An arch was attractive but soil conditions were not suitable to take the arch thrust. A prestressed concrete segmental box-girder was aesthetically acceptable but would cost more than a welded steel plate-girder." Also, the railroad would not allow cast-in-place concrete or shoring over its tracks, so a conventional concrete box-girder superstructure could not be used.

To make a steel plate girder bridge not just economically acceptable but also aesthetically acceptable, the designer opted to use an integral pier cap system. Unpainted weathering steel was used on the four-span structure both to reduce maintenance costs and to complement the nearby brown Sierra Nevada mountains.

"The north-south alignment of the center line of the McCarran Boulevard Bridge suggested a wide overhanging deck to create changing shadows as the sun passes overhead during the day," Seim said.

"Wide spacing of the steel girders is not only a structural requirement to accommodate a wide overhang, but provides the advantage of lower costs in the fabricating, transporting and erecting of steel girders."

Aesthetic Considerations

To create an uncluttered view from below the bridge, deck width was limited to 95', which only required two columns for support at each bent. The cross-section of the column is a simple rectangle, clipped at each corner to form a lozenge shape that conforms to the shape of the special seismic reinforcement within the column. "The double interlocking spiral is a very efficient method of confining column reinforcement in high seismic areas," according to Seim.

A white bonded grout surface finish contrasts the vertical lines of the columns with the horizontal lines of the brown steel girders and harmonizes with the snowy ice fields in the adjacent mountains.

The horizontal sweep of the steel girders was further accentuated by framing the columns directly into steel cross beams constructed at each bent within the depth of the girders. "This simple idea improved the appearance of the bridge and provided a clean, uncluttered view of the underside of the bridge," Seim said. "The idea also had an economic benefit, as it saved the cost of forming and placing additional concrete for a conventional column cap."

The bridge is structurally continuous over all four spans, with deck joints only at the abutments, and the facia girders are detailed to conceal their connections to the integral cross girders. "A very clean, continuous line was achieved in the outer girders, accentuating the continuity of superstructure" Seim stated. □

McCarron Bouldevard Bridge

Completion Date:
November 1989
Span Lengths:
93', 145', 165', and 133'
Roadway Widths:
95'
Steel Wt./Sq. Ft. of Deck:
25.5 lbs./sq. ft.
Steel Tonnage:
650 tons
Total Cost:
$3,842,000
Design Firms:
T.Y. Lin International, San Francisco, CA
Consulting Firm:
SEA Engineering, Sparks, NV
General Contracting Firm:
Centric Jones, Lakewood, CA
Steel Erector:
Skyline Steel Erectors, Glenwood Springs, CO
Owner:
RTC Regional Transportation Commission

AISC Prize Bridge Award

Short Span

Susquehanna Street Bridge, Allentown, Pennsylvania

A massive, deteriorating ten-span viaduct was replaced with a gracefully sweeping four-span curved steel beam bridge in Allentown, PA, to reestablish a key transportation link to the center of the city.

"The old viaduct was obsolete geometrically and structurally," explained George W. Zuurbier, vice president of structures for McTish, Kunkel & Associates, Allentown. In addition to its advanced state of deterioration which imposed a ten-ton load restriction, the predominantly concrete structure had a limited width that impeded traffic flow. "It was a real dog," Zuurbier said.

The first thought was to replace the viaduct, which crossed both a rail line and pedestrian walkways in a park area, with a precast, prestressed concrete structure. However, the 43' height of the crossing meant that piers were very expensive. "With prestressed concrete, we needed a lot of piers. The cost of the piers drove us to seek longer spans, and that led us to a continuous rolled steel beam bridge. We needed to minimize structural depth and cost while maximizing spans and aesthetics," Zuurbier said.

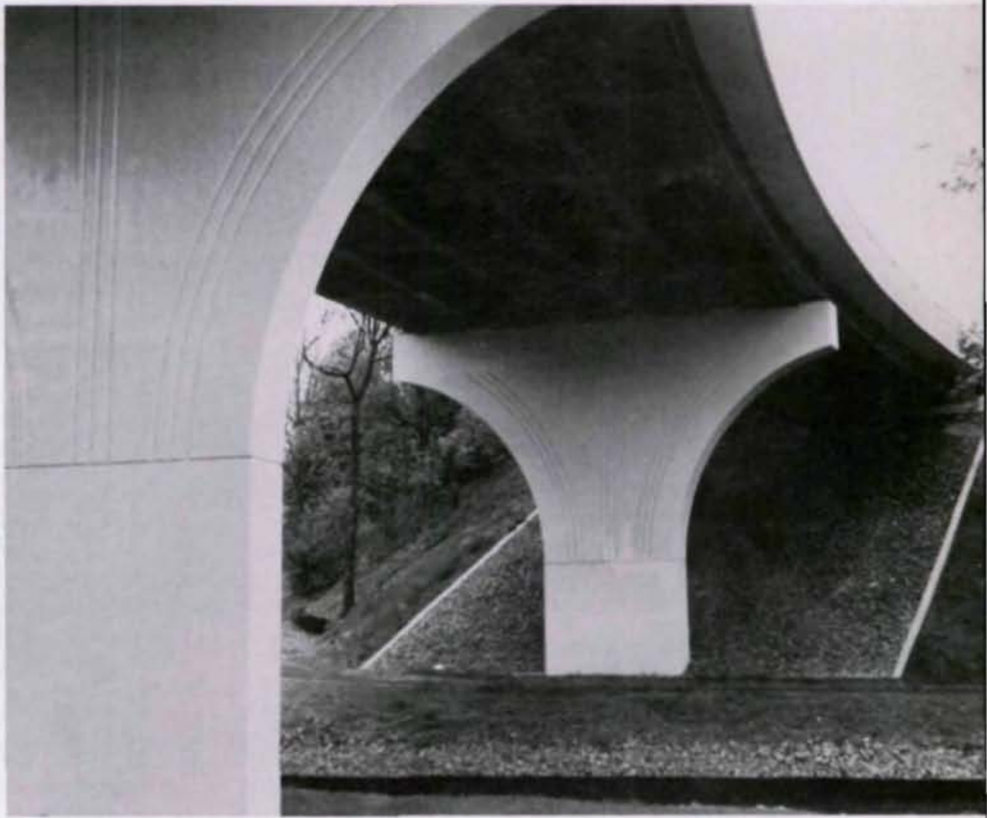
"The use of continuous curved steel beams was a natural solution to a combination of tight vertical clearance and fixed horizontal alignment dictated by approach geometry," he explained.

The structure, which was fabricated of A572 steel, has four spans, two of 60' and two of 80'. One end span was made shallower to clear the railroad tracks, though by making a smooth fairing there was little noticeable visual impact.

"Aesthetics were an important consideration," Zuurbier stated. "The city was very serious that we didn't do just a plain bread-and-butter stream crossing. The use of continuous steel beams gave us very nice lines."

The importance of aesthetics also led the designers to omit the coverplates over the piers. Instead, the beam sizes were increased slightly. "There would have been a very small savings by using coverplates, but it would have been a visual distraction. We instead chose to simplify fabrication and get a better appearance."

The bridge's piers were flared for aesthetic reasons and the connection of transverse diaphragms to the flanges of the main longitudinal stringers were flared for fatigue strength. "As it turned out, these elements complemented each other nicely, and it created both functional and visual attractiveness," Zuurbier added. □



Susquehanna Street Bridge

Completion Date:
October 1989

Span Lengths:
60', 80', 80' and 60'

Roadway Widths:
40'

Steel Wt./Sq. Ft. of Deck:
49.1 lbs./sq. ft.

Steel Tonnage:
275 tons

Total Cost:
$2,200,000

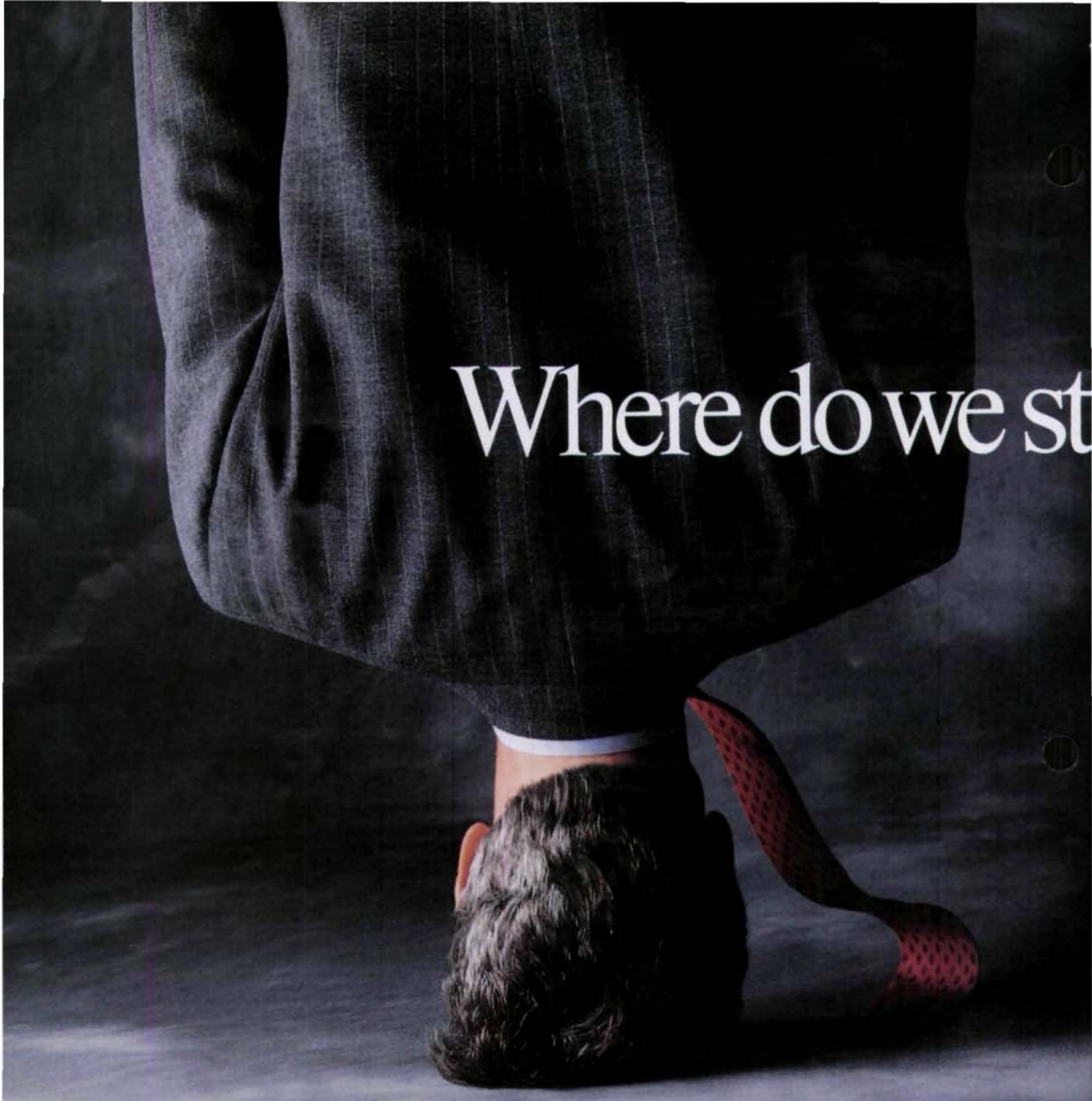
Design Firm:
McTish, Kunkel & Associates, Allentown, PA

Consulting Firm:
Jupiter Engineering, Allentown, PA

General Contracting Firm:
H.J. Williams, Inc., York, PA

Steel Erector:
M.A. Hospador Steel Erectors, Inc., St. Clair, PA

Owner:
City of Allentown (PA)



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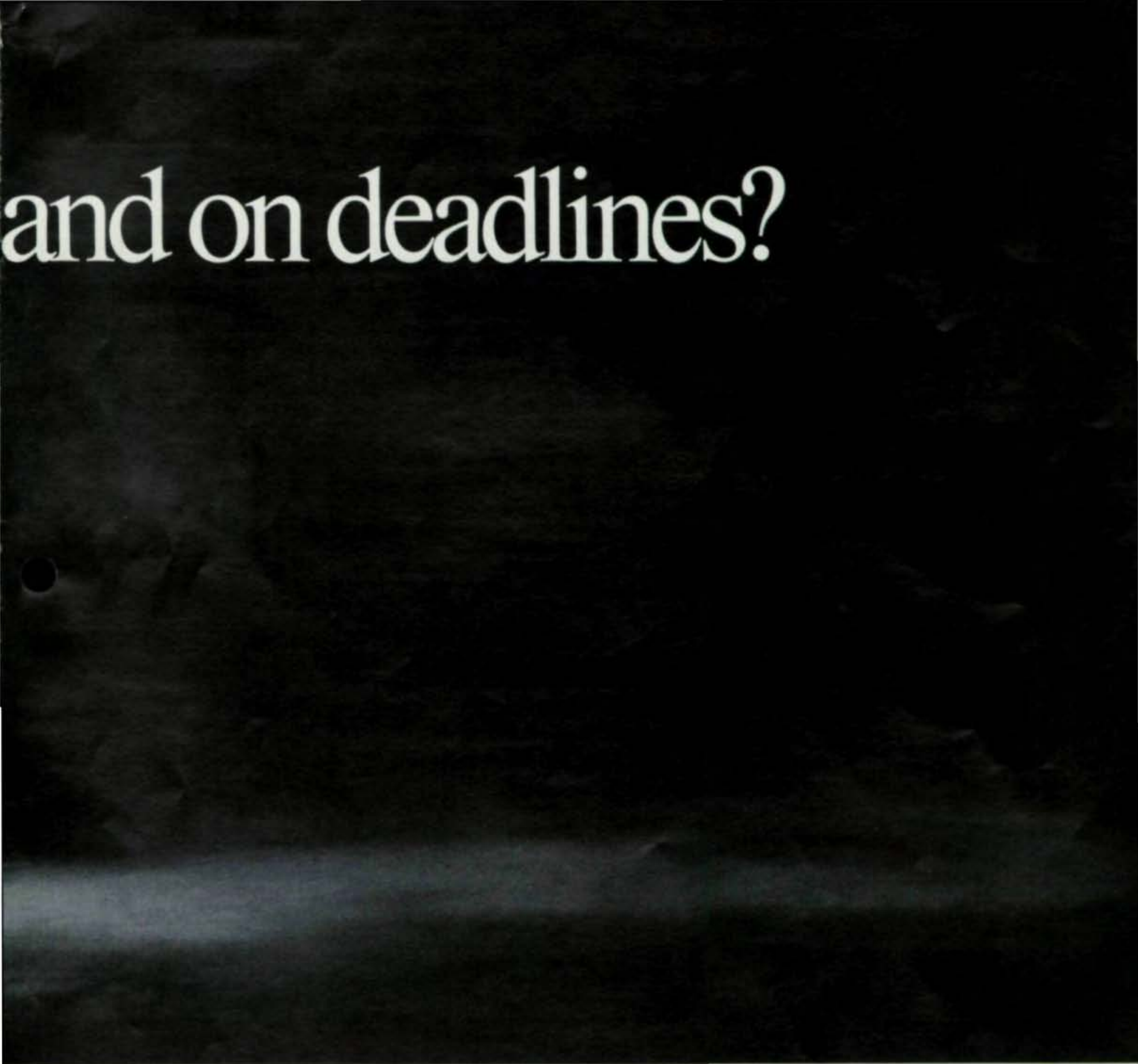

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AISC Award of Merit

Short Span

St. Peter Street Bridge, St. Paul, Minnesota

A deteriorating and geometrically inadequate bridge was recently replaced with a modern steel bridge in downtown St. Paul.

Although the existing structure was a concrete box girder bridge, the Minnesota DOT opted not to replace it with a similar structure due to maintenance problems with those types of bridges, according to Robert Miller, P.E., bridge design unit leader with MDOT. "Also, the degree of curvature on about a third of the bridge clearly indicated that steel was the best solution," he added.

The bridge is one of the connecting links between the downtown area and the State Capitol complex and spans Interstate 35E-Interstate 94 commons area.

The new structure consists of seven short spans with a total length of 484'. Six of the spans are continuous with lengths varying from 58' to 92', while a simple span was used for the seventh span due to its short, 32' length and because the use of a simple span avoided uplift at the abutment. Because of high retaining walls on both sides of the bridge and an adjacent frontage road, it was impractical to remove all of the old abutment, so a portion of the west abutment from the previous bridge was retained.

Three of the bridge's spans curve 28.5 degrees. Also, because of several roadways below the bridge, the piers have various skews. The skews, along with the curvature of the bridge, result in widely varying beam lengths in some spans.

Limitations of vertical clearance required beams smaller than would normally be used with the total length involved—a welded plate beam with a 3' depth was the deepest beam that could be used—thus a series of short spans were designed. Because of the shallowness of the beams and the curvature of the bridge, a beam spacing of 8'-4" was used, Miller said.

Aesthetic Design

Recently, the governor of Minnesota has instituted a Capitol Complex beautification program to give the area around the State Capitol a unique appearance and reflect the architecture of the Capitol buildings. The continuous girders created a clean appearance for the structure, which also was given a unique character through the use of a special ornamental metal railing and decorative lighting. □

St. Peter Street Bridge

Completion Date:
June 1990
Span Lengths:
32' to 92'
Roadway Widths:
31'
Steel Wt./Sq. Ft. of Deck:
30 lbs./sq. ft.
Steel Tonnage:
356 tons
Total Cost:
$1,760,940
Design Firm:
Minnesota Department of Transportation, St. Paul, MN
General Contracting Firm:
Edward Kraemer & Sons, Inc., Plain, WI
Steel Erector:
Brian Mitchell Construction Co., Green Spring, WI
Owner:
Minnesota Department of Transportation

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AISC Award of Merit

Railroad

Soo Line Railroad Bridge over Marshall & Snelling Avenues, St. Paul, Minnesota

As part of the improvement of the intersection of Marshall and Snelling Avenues, the Minnesota Department of Transportation replaced the two Soo Line Railroad bridges that crossed the intersection at a 40 degree skew.

The existing railroad grade separation structures consisted of a four-span concrete viaduct over Marshall Avenue and a three-span steel and concrete bridge over Snelling Avenue. In addition to carrying two Soo Line Railroad tracks, they also carried a steam pipeline.

The site constraints and the severe skew of the roadways with respect to the existing railroad alignment presented several design and construction problems. In addition, rail operations and vehicular traffic had to be maintained at all times, and all utilities had to be kept in service throughout construction.

The new structure is a three-span, single-track ballasted deck structure comprised of welded through plate girders. The girders are approximately 12' deep and the floor system is made up of transverse floor beams and a steel plate deck.

The 171'-long span over Marshall Avenue and the 113'-long span between the roadways are skewed sharply to satisfy the site geometry. As a result, the framing of the floor system at the skewed ends of these spans is quite complex. The 144' long span over Snelling Avenue has two square ends. "The utilization of long steel spans on this project eliminated the need for large skewed piers located in the roadways and resulted in substantial cost savings," according to Charles L. Ballou, P.E., a principal with Bakke Kopp Ballou & McFarlin Professional Engineers, Minneapolis. In

addition, a concrete structure would have been impractical due to the headroom constraints presented by the existing roadways.

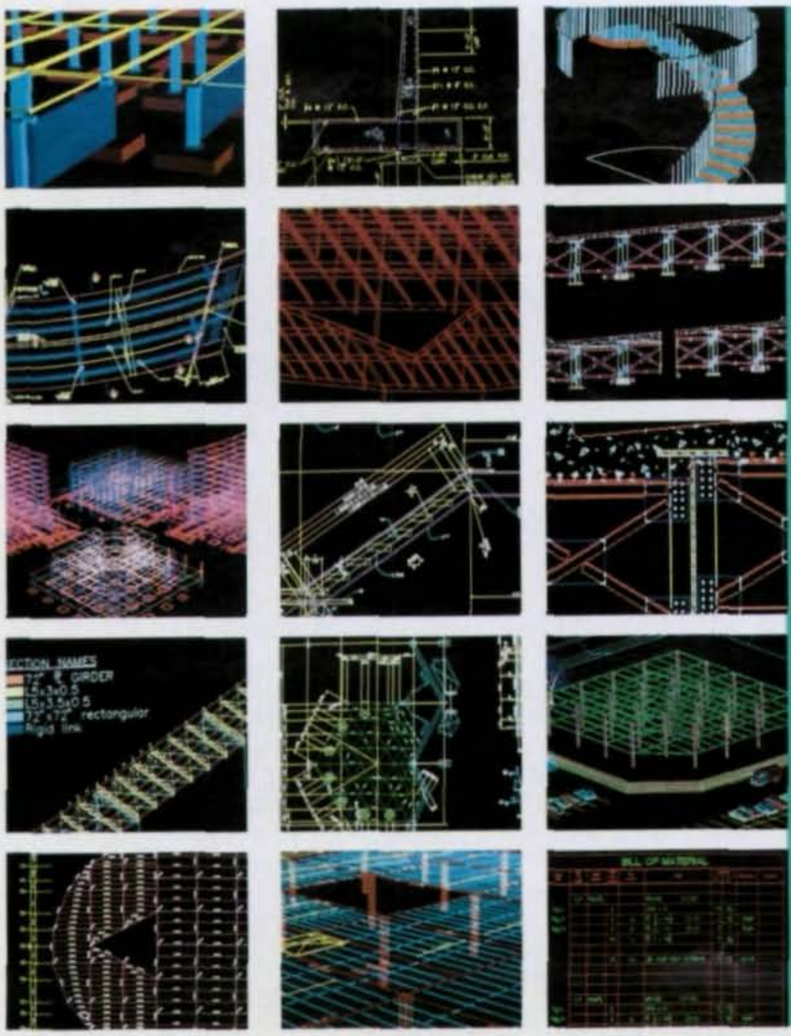
As part of this project, an independent bridge structure was designed and constructed to support the existing steam pipeline. The steam pipeline bridge is adjacent to the railroad structure and is of similar design using long span welded steel plate girders.

Construction staging entailed relocating the live railroad track to one side on the existing bridges and building a temporary structure to support the steam pipeline. A portion of the existing bridges was then removed to facilitate construction of the new railroad substructure. After the railroad spans were

set on the completed substructure and the track shifted to its final location, the remaining portion of the existing bridge was removed to allow construction of the pipeline substructure. Once the spans were set and the pipeline relocated, the temporary pipeline bridge was removed. □

Snelling & Marshall Railroad Bridge

Completion Date: May 1990
Span Lengths: 171′, 113′, 144′
Roadway Widths: 21′ and 12′
Steel Wt./Sq. Ft. of Deck:
138 lbs./sq. ft.
Steel Tonnage: 985.5 tons
Cost: $5,200,000
Design Firm:
Bakke Kopp Ballou
& McFarlin Prof. Eng.,
Minneapolis, MN
Consulting Firm:
Alfred Benesch & Co.,
Chicago, IL
General Contracting Firm:
Lunda Construction Co.,
Rosemount, MN
AISC Member Fabricator:
Phoenix Steel Inc.,
Eau Claire, WI
Steel Erector:
Hi-Boom Erecting, Inc.
Black River Falls, WI
Owner:
Minnesota Dept. of Trans.



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The Trump Taj Mahal's 44-story hotel tower presented a unique structural engineering problem to Otokar (Pete) von Bradsky. The design called for a 420 foot tower, 350 feet in length by only 68 feet in width. Yet, it had to withstand Atlantic City's potentially hurricane force winds of up to 100 m.p.h.

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AISC Prize Bridge Award

Elevated Highway or Viaduct

SR-386/I-65, CSX R.R., Two-Mile Pike, Nashville, Tennessee

The need to minimize the number of piers led the Tennessee Department of Transportation to choose a continuous welded plate girder bridge to connect an urban interstate highway with a newly constructed bypass.

"We looked at a prestressed concrete bridge, but we needed a design with as few piers as possible and one which would provide the needed vertical clearance," explained Edward P. Wasserman, P.E., civil engineering director of structures for Tennessee DOT. Steel was the obvious answer for achieving the desired span length while also accommodating the needed curvature.

The bridge is required to span the mainline of an interstate railroad, an urban arterial highway, and part of a fully developed shopping center.

To achieve the necessary vertical clearances, the designers opted to use integral pier caps in three locations.

Integral, cast-in-place, post-tensioned concrete bent caps were thrust between continuous steel welded plate girders at the interstate median and the shoulder of the road away from the abutment to conserve headroom and avoid the impacts of the severely skewed crossing of the interstate.

An integral steel bent cap, spanning 60' and supporting 164' of bridge span was used to allow passage of an entrance to the shopping center between supporting columns. The details of the integral steel cap were designed and detailed to eliminate biaxial tensile stresses in the flanges of the cap. "A steel cap worked out better in this area than a concrete cap because of the considerable width of the structure and the limited number of available column locations," Wasserman explained.

Bent locations, span arrangements and superstructure materials were selected to maximize the joint use areas underneath the structure over the shopping center and to provide the desirable horizontal and vertical clearances over the highways and railways. Also, the roadway was designed to minimize the total vertical distance from the finished grade of the bridge to the features crossed, and to minimize disruption. □

SR-386/I-65, CSX R.R., Two-Mile Pike

Completion Date:
January 1991
Span Lengths:
136', 179', 148', 118'
Steel Wt./Sq. Ft. of Deck:
39.93 lbs./sq. ft.
Steel Tonnage:
3,785 tons
Total Cost:
$9,000,000
Design Firm:
Division of Structures, Tennessee Department of Transportation, Nashville, TN
General Contracting Firm:
Rogers Group, Inc., Nashville, TN
AISC Member Fabricator:
Carolina Steel Corp. Greensboro, NC
Steel Erector:
Sentry Steel Service Co., Madison, TN
Owner:
Tennessee Department of Transportation

AISC Prize Bridge Award

Grade Separation

I-10/I-17 Interchange, Phoenix, Arizona

A steel girder system with a shallow superstructure and limited lateral bracing proved the most economical option for a major interchange in Phoenix.

The I-10/I-17 Interchange connects the two roadways with a complex four-level

I10/I17 Interchange

Completion Date: August 1989
Span Lengths: 120′ to 250′
Roadway Widths: 27′-2" to 79′-2"
Steel Wt./Sq. Ft. of Deck:
- 25.1 lbs./sq. ft. (mainline)
- 41.3 lbs./sq. ft. (curved ramp)

Steel Tonnage: 19,700 tons
Total Cost: $55,000,000
Design Firms:
- Parsons, Brinckerhoff Quade & Douglas, Inc., New York, NY
- HDR Engineering, Inc., Omaha, NE

General Consultant:
- Howard Needles Tammen & Bergendoff Phoenix, AZ

General Contracting Firms:
- Tanner Construction, Phoenix, AZ
- Kasler Corp., Highland, CA

AISC Member Fabricator:
- Utah Pacific Bridge &Steel, Pleasant Grove, UT

Steel Erecting Firms:
- Schuff Steel Co., Phoenix, AZ
- Adams & Smith/McGrath, Concord, CA
- Mohawk Bridge & Iron, Phoenix

Owner:
- State of Arizona DOT

multidirectional interchange. It consists of eight high- and low-level ramp viaducts and an elevated mainline interstate roadway that rises up to 87′ high. Varying in length from 720′ to 3,940′, the ramp widths range from 27′ to 39′ and their curvature varies from 400′ to 2,000′.

HDR Engineering, Omaha, was responsible for the design of the twin 4,200′ mainline viaducts. The viaducts are primarily on tangent and each consist of five multi-span units that are 79′-2″ wide, except where they flair to meet the interchange ramps. The mainline structures have a six-girder cross section with 14′ spacing for the constant width and nearly 16′ spacing for flaring units. Finite element analysis was used to compute project-specific live-load distribution factors.

All of the ramps, which were designed by the New York City office of Parsons Brinckerhoff Quade & Douglas, Inc., are curved, multi-span units. A three-girder system with a composite cast-in-place deck slab was chosen for the one-lane ramps and a four-girder system with a composite cast-in-place deck slab was chosen for the two-lane ramps.

The cost effectiveness of the steel interchange revolved around design features that reduced the depth and length of superstructure spans and avoided bulky and costly lateral bracing, according to Vijay Chandra, P.E., vice president of Parsons Brinckerhoff Quade & Douglas. "Superstructure depth was reduced by building the girders into integrally framed steel pier caps with redundant load paths for improved reliability," he explained. "This provided the necessary clearance over the busy interstate. The alternative would have been to raise the piers and pier caps for higher clearance, driving the entire project into higher, longer spans—and higher costs."

Another cost saving measure was to avoid the use of lateral bracing wherever possible. "We increased the flange size while maintaining the normal crossframe spacing, and thereby virtually eliminated lateral bracing," Chandra said. "It was only used in the vicinity of steel pier caps on one ramp that could be struck by overheight vehicles traveling on the interstate below." Analysis showed that enlarging the flanges needed for the curved girders would provide ample stiffness in most locations without bracing.

The ramp structures consist of up to five-span continuous curved girder units, designed by the load factor method and using hybrid design in which girder webs were of normal-strength steel and flanges of high-strength steel. The grid approach of the CUGAR program, coupled with design programs developed in-house, provided an efficient design for the girders. The load factor design method as well as hybrid and mixed girder design also helped achieve economies in the design of the mainline.

The project was completed on-budget and on-time. □

AISC Award of Merit

Grade Separation

Bridge "B" over MCO Entrance Road, Orlando, Florida

The need to accommodate a 19 degree curvature while still creating a structure with that would enhance driver's sightlines led the designers of a new Return Road Interchange at the Orlando International Airport to choose a twin trapezoidal, steel box girder bridge.

The structure, 285' in length, carries two lanes of returning traffic from Terminals A and B across the airport's entrance road. The bridge is located on a 300' radial alignment as it spans a four-lane lower roadway.

"Line-of-site for the entering traffic was of particular concern as various merge activities occur just beyond the bridge location," explained Bruce A. Moulds, P.E., director of structural engineering for the Atlanta office of Howard Needles Tammen & Bergendoff. "The wide open three-span structure with deep abutments set well beyond the roadway edges was selected to enhance the reaction time of the entrance road users to merging vehicles."

In addition, Moulds said, the twin steel box superstructure is supported by a cross girder and single pedestal pier to reduce the tunnel effect more traditional piers would create on a roadway with such a large skew.

"Use of continuous, composite twin trapezoidal steel box girders were the logical choice considering the bridge's sharp curvature and the Airport's emphasis on aesthetics," Moulds said. The lines formed by the deck overhangs and the webs of the 54" box were carried beyond the end of the superstructure and into the abutments to help blend the bridge into the landscaped surroundings. "The retaining walls were designed to look like a continuation of the box," according to Moulds. □

Bridge "B" Over MCO Entrance Road

Completion Date:
October 1990

Span Lengths:
90', 115', 90'

Roadway Widths:
45'

Steel Wt./Sq. Ft. of Deck:
30 lbs./sq. ft.

Steel Tonnage:
230 tons

Total Cost:
$2,325,000

Design Firm:
Howard Needles Tammen & Bergendoff, Orlando, FL

General Contracting Firm:
Hubbard Construction Co., Orlando, FL

AISC Member Fabricator:
Carolina Steel Corp., Greensboro, NC

Steel Erecting Firm:
V & M Erectors, Pembroke Pines, FL

Owner:
Greater Orlando Airport Authority

AISC Prize Bridge Award

Movable Span

U.S. 10 over St. Croix River, Prescott, Wisconsin

When the Wisconsin Department of Transportation decided to replace a deteriorated vertical lift bridge over the St. Croix River, public opinion was firmly in favor of a bascule bridge.

"The existing two lane vertical lift bridge had serious structural and mechanical problems," said Stanley J. Sylwestrak, P.E., president of Hazelet + Erdal, Inc., Chicago. The new structure provides four lanes of traffic on its 54'-wide roadway. In addition, it features an 8'-wide combination sidewalk and bikepath on its north side.

To meet the requirement for the 160' navigation channel, a double leaf rolling lift bascule with leaf cantilever lengths of 90'-6" was selected. Each leaf consists of two welded plate bascule girders, welded plate girder floor beams or bolted floor beam trusses and bolted tees as stringers, which support a steel open grid floor on the front arm of a reinforced concrete deck on the rear arm. The concrete counterweight is supported by vertical and horizontal trusses embedded in the concrete.

The rolling lift design was selected because it can provide the necessary clear channel opening with approximately a 10% reduction in length of cantilever arm compared to that needed with a trunnion bascule.

"This savings in bascule span length has additional importance on the rear arm of the girders and the counterweight," Sylwestrak explained. "For any weight eliminated from the front arm, approximately three times that weight is removed from the counterweight. The shorter arm also reduces the area of the moving leaf exposed to the wind. These factors, coupled with the reduced rolling friction in operation, account for about a 20% reduction in required power compared to that required to operate a comparable trunnion bascule bridge."

The bascule girders were fabricated in two pieces and spliced in the field with high strength bolts. High strength steel segmental castings are fastened to the girders to form a portion of a wheel with a radius of 10'. "These castings serve as bearings to transmit all loads directly into the substructure," Sylwestrak said. "Pairs of segmental casting stiffeners are extended from the casting web to form sockets that engage mating elements on alternate sides of the horizontal track casting to maintain alignment of the span during opening and closing movements."

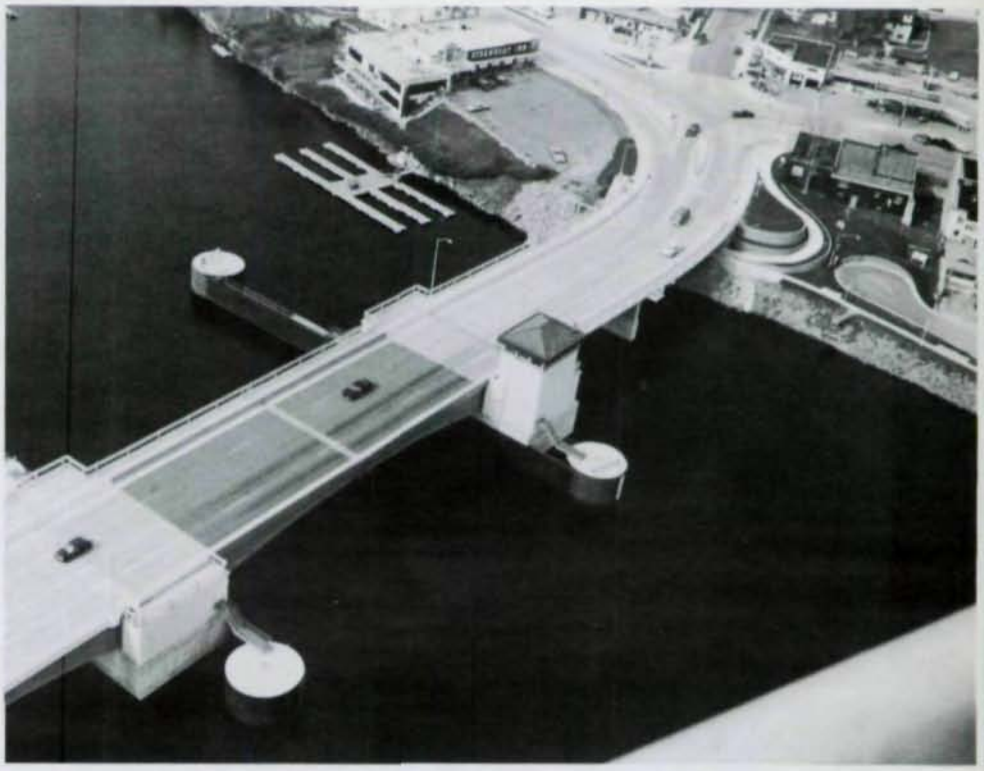
Approaches

The two approaches are parallel stringer spans made up of eight welded, two span continuous plate girders acting compositely with the reinforced concrete deck in the positive moment areas. Steel cross frames provide lateral distribution of surface loads to the stringers.

Shop connections were either welded or high strength bolted, while all field connections except for the grid floor utilized high strength bolts. The steel grid floor was welded to the flanges of tee sections, which were bolted to the web of inverted tee sections to form supporting stringers. This detail provides an economical method of replacing the grid in the future. The open grid deck is supported by asymmetrically split W21 sections bolted together to form stringers 17-1/2" deep. When the grid needs replacing, the design concept allows the 4" upper tee to be replaced with a standard size 4" tee section. □

US 10 Over St. Croix River

Completion Date: Feb. 1991
Span Lengths:
115', 125'-3", 108'-3", 108', 222' (bascule)
Roadway Widths: 54'
Steel Wt./Sq. Ft. of Deck:
58.8 lbs./sq. ft.
Steel Tonnage: 1,345 tons
Total Cost: $12,500,000
Design Firm:
Hazelet + Erdal, Inc., Chicago, IL
Consulting Firm:
Teng & Associates, Chicago, IL
General Contracting Firm:
Lunda Constr. Co., Black River Falls, WI
AISC Member Fabricator:
Phoenix Steel, Eau Claire, WI (approaches)
Vincennes Steel, Vincennes, IN (bascule)
Steel Erecting Firm:
Hi-boom Erecting, Inc., Black River Falls, WI
Owner:
Wisconsin DOT



AISC Award of Merit

Movable Span

Greenpoint Avenue Bridge, New York City, New York

When an inspection of one of New York City's busiest movable bridges revealed that the bascule piers were rotating toward midspan via differential movement, the New York State Department of Transportation decided that the bridge needed to be replaced. "Because of the foundation condition, it was determined that any repair to the structure would be short term and that the old span should be replaced," explained Richard W. Christie, P.E., a partner with Hardesty &

Greenpoint Avenue Bridge

Completion Date:
June 1989
Span Lengths:
204'
Roadway widths:
56'
Steel Wt./Sq. Ft. of Deck:
150 lbs./sq. ft.
Steel Tonnage:
1,000 tons
Design Firm:
Hardesty & Hanover, New York, NY
General Contracting Firms:
(joint venture)
Morrison-Knudsen Co., New York, NY
Yonkers Contracting Co., New York, NY
AISC Member Fabricator:
Harris Structural Steel Co., Inc., Piscataway, NJ
Steel Erecting Firm:
RICE-Mohawk U.S. Construction Co., Ltd., Bronx, NY
Owner:
New York City DOT/ New York State DOT

Hanover, New York.

The Greenpoint Avenue Bridge spans the Newtown Creek separating the boroughs of Queens and Brooklyn and has an average of 2,000 openings per year. In addition to heavy marine traffic, the four-lane roadway is clogged with commercial and passenger vehicle traffic enroute to-and-from midtown Manhattan.

All four leaves of the old bridge had independent machinery drives. The need to keep the structure open to vehicular structure at all times led to the design of a new four leaf configuration. "Our scheme was to partially demolish a corner of the old bridge to allow the construction of half of the new bascule piers and half of the new bascule span superstructure," Christie said. "After the first stage was completed, demolition of the remaining portion of the old bridge could be completed and the second half of the new bridge constructed."

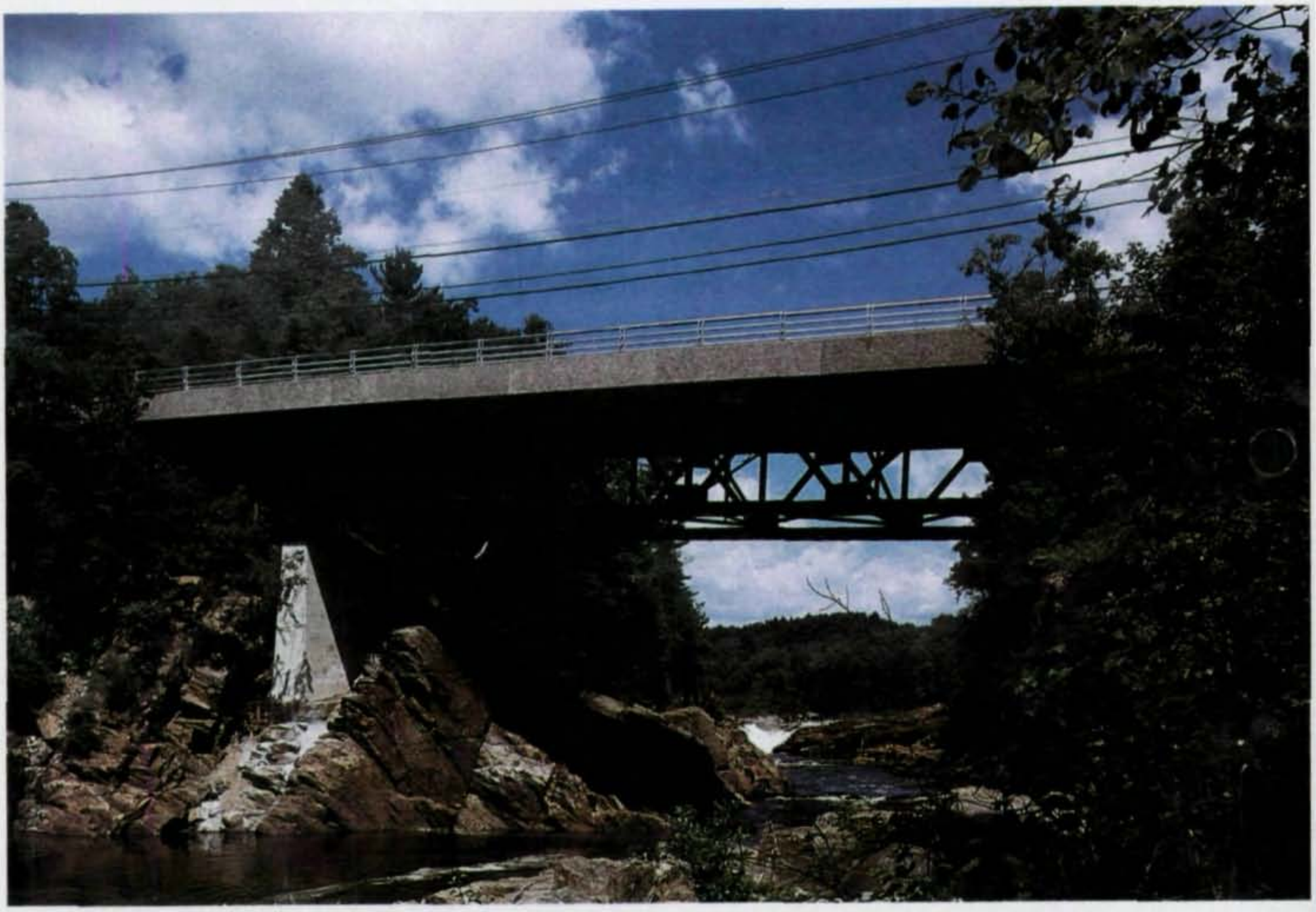
The new bridge is a simple trunnion arrangement with the centerline of trunnions 202' on centers. The distance from the trunnion to the heel is 31', making each girder 133' long. Girder depth is 15' at the trunnion, 5' at the toe, and 15' at the centerline of the counterweight. The bascule span is typical floorbeam and stringer framing. The floorbeams are spaced at 22'-4-1/2" on centers and they frame into the bascule girders. The stringers are continuous over the floorbeams and are spaced typically at 4'-6" centers. The stringers support a 5"-deep steel grating that is partially filled with an epoxy mortar with basalt aggregate. The two bascule girders are 30'-6" apart and the two center bascule girders are 2'-10" apart.

While the design for the trunnion columns was simple in detail, it still required special consideration. "The space between girders was so tight it was necessary to have both inboard girder trunnions supported on one column and one bearing," Christie explained. "The trunnion would be loaded and operational with the first stage leaf for a considerable period of time until the second stage leaf was ready for erection. Because of possible axial shortening of the center column when the stage two leaf was added, which could have produced undue wear or bonding of the trunnion bearing already in place, we had the center column designed to meet what we felt were appropriate limits for axial misalignment of the trunnion shafts." Also, the columns supporting the outboard bascule girders were cambered for dead load axial shortening.

The length of the live load arm made forward live load supports desirable, according to Christie. The forward towers became part of the truss with the trunnion columns becoming the rear leg. The trunnion tower trusses were made up of welded plate horizontal and diagonal members with the diagonals also supporting the main pinion bearings. The truss members were bolted together after the accuracy of the erection was verified.

With the simple trunnion configuration, the tower supported uplift to each trunnion bearing. □

Why is Bethlehem's w
in the Inverset™
Here's the long a



Bethlehem's weathering steel and the innovative Inverset bridge system are a perfect fit.

Inverset offers engineers an economical solution for a wide variety of bridge requirements—whether for long-span, short-span, new construction or bridge replacement projects.

And that's important. Because, according to FHWA estimates, of some 580,000 bridges in the country, over 40% are structurally deficient or functionally obsolete.

The Inverset bridge system, manufactured in the Northeast by The Fort Miller Company, uses upside down deck casting techniques to provide a high-quality, pre-compressed concrete deck on lightweight prestressed steel stringers. This results in an economical unit ready for field placement. Additional savings are gained through rapid erection and minimum out-of-service time. The modules can be placed either longitudinally or transversely. Their light-weight design characteristics make Inverset the ideal solution where dead load is a constraint.

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The use of high-strength ASTM A588 weathering steel beams adds to the overall economy—both initially and down the road.

Compared to ordinary ASTM A36 steel, weathering steel's 38% higher yield strength permits structures to have lighter, slimmer sections. And since weathering steel resists corrosion, painting is rarely required. In addition, weathering steel's rich, brown oxide coating blends with the environment without disturbing it.

eathering steel used Bridge System? nd the short of it.

Bethlehem's weathering steel was recently used by The Fort Miller Co. in two upstate New York projects. The Rockwell Falls Bridge rehabilitation project for the Hudson River Bridge at Lake Luzerne, NY, required just 28 days of downtime. The units, which were positioned transversely, replaced the existing floor beams and deck on the 180-ft.-long bridge.

The erection of the Outlet Road Bridge in Saratoga County, was completed in half a day. Three 9-ft. $6\frac{1}{2}$-in.-wide units were used longitudinally on the 35-ft.-long structure.

The Fort Miller Co. is sold on the aestehtics and cost-ing benefits of weathering steel. We think you'll be, too.

o get a copy of our Product Booklet, No. 3790 and our latest Technical Bulletin, TB-307 on "Uncoated Weathering Steel Structures", Call: **(215) 694-5906.**

Bethlehem Steel Corporation, Construction Marketing Division, Bethlehem, PA 18016.

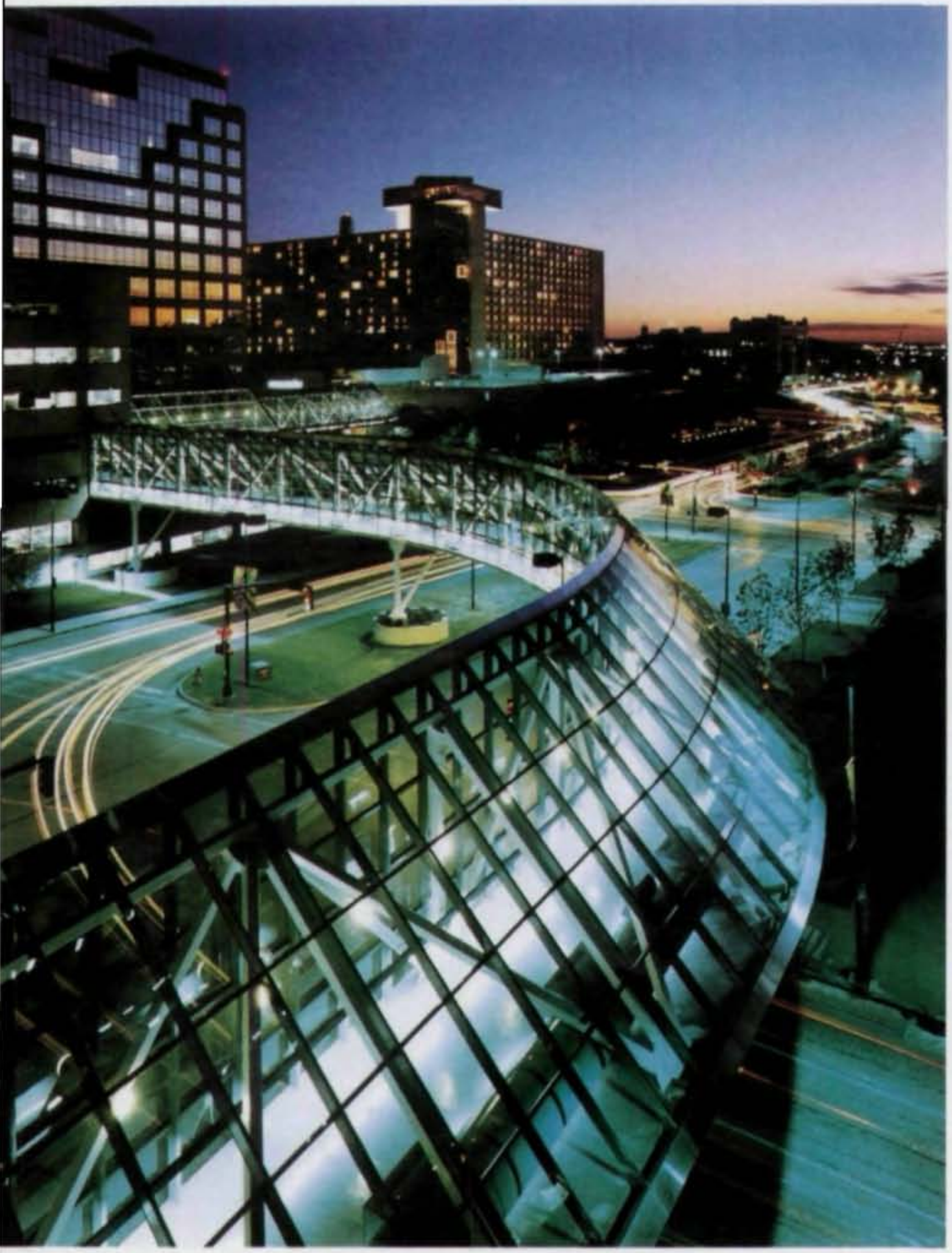
Rockwell Falls Bridge: (left)
Owners: Saratoga and Warren Counties, State of New York
Fabricator: Seibel Modern Manufacturing and Welding Co., Lancaster, NY
General Contractor: J. H. Maloy, Inc., Albany, NY
Outlet Road Bridge: (right)
Owners: Saratoga County, State of New York
Fabricator: Seibel Modern Manufacturing and Welding Co., Lancaster, NY
General Contractor: Schultz Construction Inc., Round Lake, NY
Consulting Engineer: Greenman-Pedersen Inc., Albany, NY
Inverset Licensee: The Fort Miller Company, Inc., Schuylerville, NY
Weathering Steel Supplier: Bethlehem Steel Corporation, Bethlehem, PA

Bethlehem

AISC Prize Bridge Award

Special Purpose

The Link, Kansas City, MO



Photography by Timothy Hursley

In order to reinforce the identity of Crown Center as a unified complex, the developers realized that they needed to provide easy access from one building to another. While that may seem like an easy task, in this case it was greatly complicated by the need to span three major thoroughfares.

After examining the site, the architects, Zimmer Gunsul Frasca Partnership of Portland, suggested a triangular-shaped pedestrian walkway with sweeping curves. They envisioned "an elevated walkway which would not erode street life or be a visual detraction, but instead would make amends by being as amusing and lighthearted as it is convenient."

The serpentine structure has three distinct walkway sections spanning a total of 880′ and connecting five buildings. The glass enclosed, 18′ x 18′ triangular cross section features exposed tubular steel and 3"-thick composite cellular deck with a 2-1/2" concrete topping slab. To minimize heat gain, a green-tinted solar glass was specified. Also, the sloping glass walls easily shed ice and snow in the winter.

Complicating the project, however, was the limited number of potential support locations. "Crossing over streets and intersections severely limited the support locations," explained Mike Walkiewicz, P.E., structural engineer with KPFF Consulting Engineers, Portland. "In many cases, we could only provide supports on islands or at street corners." In addition, the architects had pre-determined a bay size of 18′, which placed geometric restraints of the curvature of the walkway.

The first section of walkway, which connects a Hyatt Regency Hotel with the 2400 Pershing office building, is the longest, spanning

325' over two roadways. Computer analysis determined that because of its geometry and triangular shape the ends of the structure should be tied to the existing structures. Intermediate supports are hinged at their base, which allows the walkway curvature to change, thus reducing thermal loads and stresses.

At the Hyatt end, the walkway is connected to an existing reinforced concrete basement wall with through bolts and drilled anchors to resist thermal and lateral loads. At the office building terminus, two 16'-long drag plates with bolts through the roof slab transfer these loads.

The triangular shape and alternating steel diagonal members of the walkway make it inherently stable and enable it to resist the torsional forces resulting from its curvature and from lateral loading. Cellular composite deck was selected to strengthen and stiffen the floor and to provide a smooth surface at the exposed walkway soffit.

The second section of the walkway is 300' long. It runs between the 2400 Pershing building and the adjacent 2405 Grand building, creating an atrium. The sloping roof structure and walkway are tied rigidly into the high-rise 2405 Grand building, and are free to move laterally at the adjacent low-rise 2400 Pershing building.

The third section, which spans 200' over a major street, connects two office buildings with the Westin Hotel complex. This section is similar to the Hyatt Regency part of the walkway with one major difference: the connecting point for this walkway coincides with an existing expansion joint between the Westin Hotel and its retail complex, which prohibits tying the walkway rigidly to the hotel. Instead, this span was rigidly tied to the office buildings. The expansion joint at the Westin end facilitates a total movement of up to 6" under thermal and lateral loads.

"The architect wanted to express the structure, so steel was the obvious choice," Walkiewicz said. However, since the steel was being exposed it meant that the structure's diagonals were laid out for their visual impact rather than for structural necessity. "The result was that some of the members were in tension, while others were in compression." The engineers, using a SAP90 program, accommodated the layout by changing the wall thickness of the 8" x 8" steel tubes.

Because of concerns for both shop and field fit-up sequencing, the steel fabricator/erector constructed a 1/4-scale mockup of two bays of the walkways, complete with scaled connection plates, which enabled any potential problems with design or erection to be easily spotted.

The walkway was shipped to the site in two-bay sections, in some cases with the deck already in place. Half-spans were then assembled in the median strip of Pershing road and lifted onto scaffolding with two cranes. This process significantly reduced the amount of required field welding.

Heavy traffic on adjacent streets dictated that span lifts could only be done during weekends. Because virtually all fit-up was done in the shop or on the ground, no field fit-up problems were encountered. Steel fabrication and erection was completed on a five-month schedule. □

The Link

Completion Date:
November 1988
Span Lengths:
880' total;
108' max.
Roadway Widths:
10' (pedestrian)
Steel Wt./Sq. Ft. of Deck:
65 lbs./sq. ft.
Steel Tonnage:
300 tons
Total Cost:
$4,829,132
Design Firm:
Zimmer Gunsul Frasca Partnership, Portland, OR
Consulting Firm:
KPFF Consulting Engineers, Portland, OR
General Contracting Firm:
J.E. Dunn Construction Co., Kansas City, MO
AISC MemberFabricator & Erector:
The Bratton Corp., Kansas City, MO
Owner:
Crown Center Development Corp., Kansas City, MO

AISC Award of Merit

Special Purpose

Geneva Spur Pedestrian Bridge, West Chicago, Illinois

Final appearance was the primary deciding factor in choosing a design for a pedestrian bridge over 10 rail tracks in West Chicago, but economics and the need to curve around an existing high voltage tower also played important roles.

"An old two-span truss bridge once crossed the tracks, but it was long gone when we started this project," said Charles D. Smith, S.E., a senior associate with Envirodyne Engineers, Inc., Chicago. However, the designers were able to use reduce costs by using the pre-existing embankments. "We tried to use the old abutments, but couldn't because of the need to curve around the high voltage tower."

Various alternates were considered before the designers settled on a steel, two-pinned arch span connected to steel girder approach spans. Among the options considered was a wood covered bridge, but it was deemed too susceptible to fire. Various concrete structures, as well as a steel truss alternate, were rejected as too difficult to curve around the tower. A full steel girder design was considered, but the arch was chosen as being more attractive.

The 494'-long bridge structure is comprised of six spans, one consisting of a 263' steel, two-pinned arch span, with the five remaining approach spans consisting of rolled steel girders. Two of the rolled steel girder spans are curved to avoid interference with the high voltage tower.

Two steel box sections were used for the arch. The height of the arch above springline is 53'-6". Since the footprint of the arch is very narrow, each arch section was placed on a 1:12 vertical batter towards each other to provide addi-

Geneva Spur Pedestrian Bridge

Completion Date:
Spring 1990

Span Lengths:
44' to 263'

Roadway Widths:
10' (pedestrian)

Steel Wt./Sq. Ft. of Deck:
44.7 lbs./sq. ft.

Steel Tonnage:
132 tons

Total Cost:
$1,200,000

Design Firm:
Envirodyne Engineers, Inc., Chicago, IL

General Contracting Firm:
Belvidere Construction Co., Belvidere, IL

AISC Member Fabricator:
Munster Steel Co., Inc. Munster, IN

Steel Erecting Firm:
AREA Erectors, Inc., Rockford, IL

Owner:
DuPage County Division of Transportation

tional stability as well as to improve the bridge's appearance. As a result, at the base there is 17'-3" between the arches, while at the top there is only 8'-4".

The steel box section ties between the two arch sections to provide a simple, clean look. The bridge walkway has a clear 10'-width with a 4'-high structural tube steel handrail on each side set into a 9" curb. The walkway in the arch span is supported on rolled steel floor beams space on 20' centers. The floorbeams were connected to the longitudinal arch tie beams and the tie beams were hung from the steel arch sections with steel tie rods. Lateral stability of the suspended walkway is provided by a steel tie rod bracket system placed below the roadway.

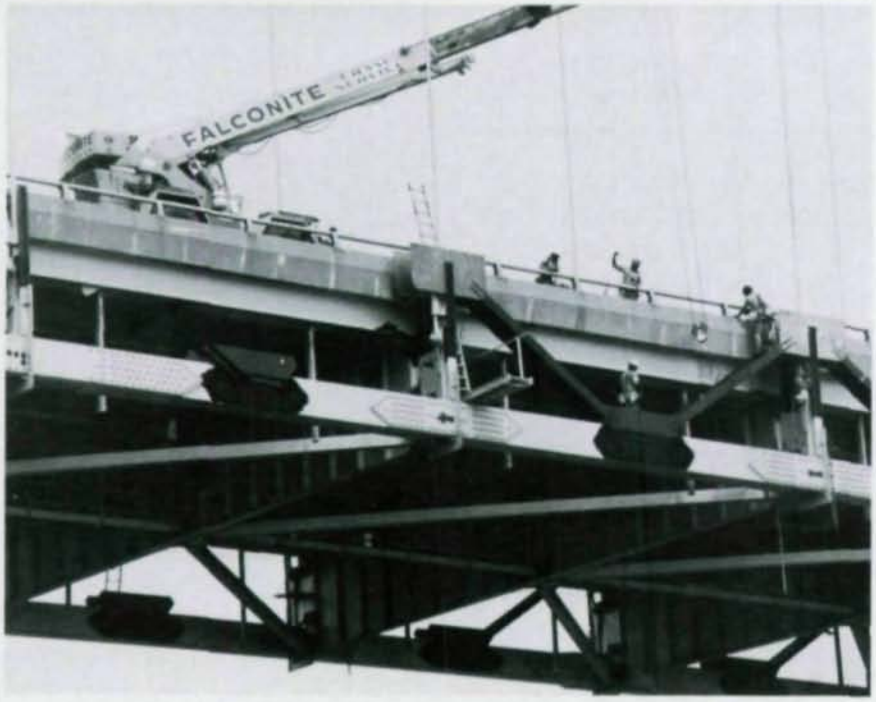
Surrounding the embankments is a wetlands area. "We had to design an erection sequence that would minimize disturbance to that area," said Smith.

Each arch is comprised of five sections, and two sections on each side of the arch were spliced together with high strength bolts on the ground prior to erection. "Two temporary supports in the rail yard were used to hold the two end sections in place while the center section was erected and bolted into place," Smith explained. □

AISC Prize Bridge Award

Reconstructed

Paducah Tied Arches, Metropolis, Illinois and Paducah, Kentucky



The Ohio River crossing of FAI 24, built in 1973, contains two major tied arch spans of 630′ and 730′. These spans have stiff compression ribs and ties with relatively light bending stiffness. And until recently, the bridge also had excessive vibration and fatigue cracking.

"There was excessive vibration even under a single truck, and that contributed to the fatigue cracking," explained John M. Kulicki, Ph.D., P.E., a partner with Modjeski and Masters, Mechanicsburg, PA. In addition, there were a lot of web gaps—small areas of unconnected metal that moved back and forth. "There were a lot of those type of details throughout the structure," he added. "The floor beam responds to the local load, while the ties to the lateral system respond to the overall load. The movement was out of sync."

Dynamic studies of the arch spans were made using the finite method and the results were compared to the vibration modes and frequencies found in the field to confirm that the structures were correctly modeled. as modifications were considered for decreasing the vibration, each was studied and evaluated for effectiveness using the finite element models.

Stiffening trusses, using the arch tie as the bottom chord, were designed and added to reduce the amplitude of the arch vibrations. The trusses were proportioned so the top was at the same level as the roadway parapet, which meant motorists would not see any addition to the bridge.

The stiffening trusses were erected while maintaining two lanes of traffic across the bridge at all times, accept for three 30-minute closings for final connections. In order to compensate for the additional load in the tie caused by the weight of the added truss members, the load in the tie was reduced by the addition of post-tensioning, which ran the full length of the span.

The completed trusses reduced the deflections and vibrations in both arch spans to an acceptable level with an accompanying reduction in stresses in floor system members.

"The addition of the trusses does not detract from the beautiful sight lines of the original arch structure—the trusses cannot be seen by the motoring public, and from a river view, the proportions are appropriate to the structure," Kulicki stated. □

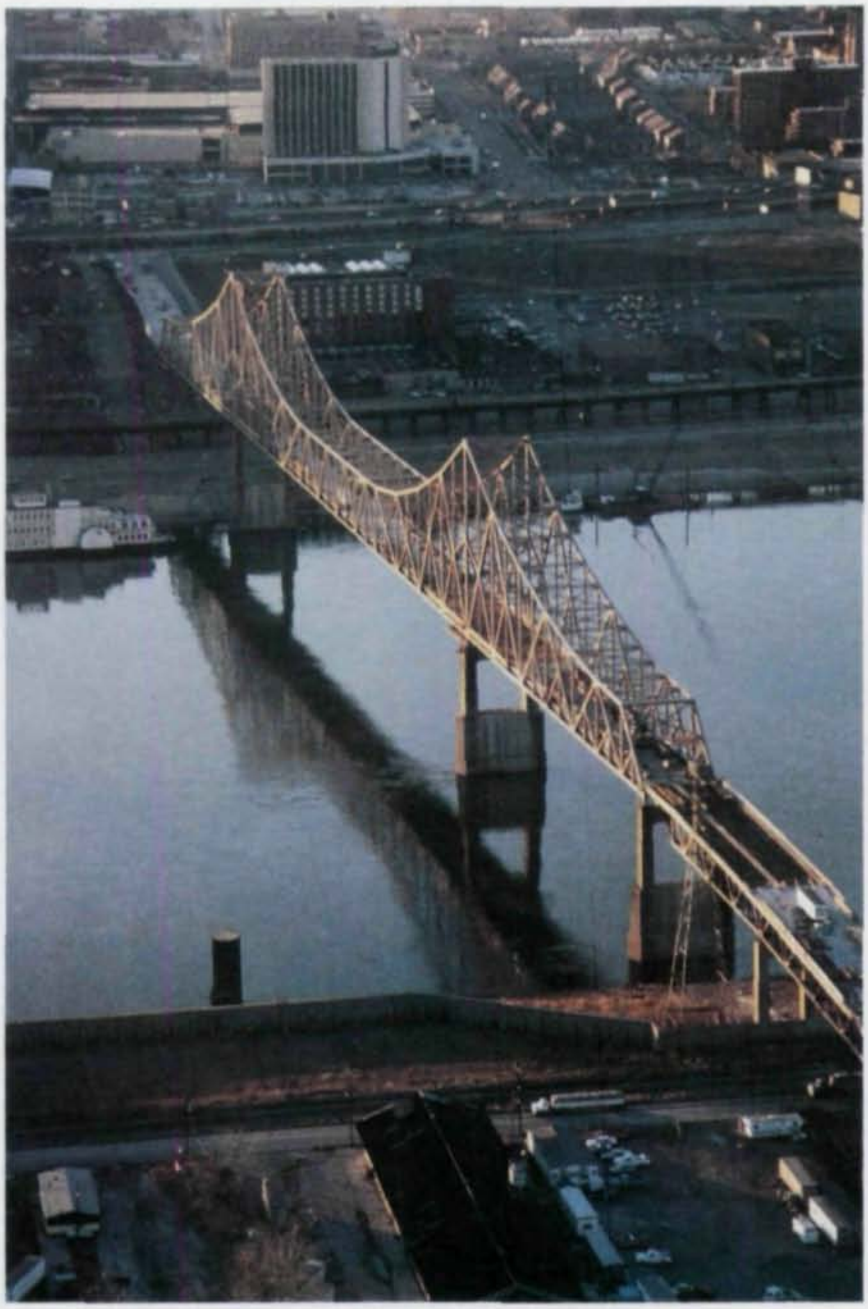
Paducah Tied Arches

Completion Date:
July 1990
Span Lengths:
630' (unit II)
730' (unit V)
Roadway Widths:
30'
Steel Wt./Sq. Ft. of Deck:
19 lbs./sq. ft.
Steel Tonnage:
824 tons
Total Cost:
$3,565,500
Design Firm:
Modjeski and Masters, Mechanicsburg, PA
General Contracting Firm:
John F. Beasley Construction Co., Dallas, TX
AISC Member Fabricator:
Vincennes Steel Corp., Vincennes, IN
Steel Erecting Firm:
John F. Beasley Construction Co., Dallas, TX
Owner:
Illinois Department of Transportation

AISC Award of Merit

Reconstructed

Martin Luther King Bridge, St. Louis, Missouri



Spanning the Mississippi River from East St. Louis, IL, to St. Louis, MO, the Martin Luther King toll bridge served as a major artery connecting the two cities for nearly 40 years.

The bridge was owned by East St. Louis, an extremely cash-strapped municipality, and as a result had undergone virtually no repairs since the early 1960s. By 1986, the bridge had deteriorated so

Martin Luther King Bridge

Completion Date:
June 1989
Span Lengths:
River Bridge: 35 spans, 4,010' total, 963' max.
Approach Bridge: 1,296' total, 250' max.
Roadway Widths:
40'
Steel Tonnage:
1,530 tons
Total Cost:
$26,000,000
Design Firm:
Sverdrup Corporation, St. Louis, MO
General Contracting Firm:
Massman Construction Co., St. Louis, MO
AISC Member Fabricator:
Stupp Brothers Bridge & Iron Co., St. Louis, MO
Steel Erecting Firms:
Ben Hur Construction Co., St. Louis, MO
Keeley & Sons, Inc., East St. Louis, IL
Owner:
Illinois Department of Transportation

badly that inspectors were worried a car would fall through its deck. The two outer lanes were closed to traffic and the structure was downgraded from its original load rating of 20-tons to a 10-ton limit. However, being a steel structure, the bridge was repairable.

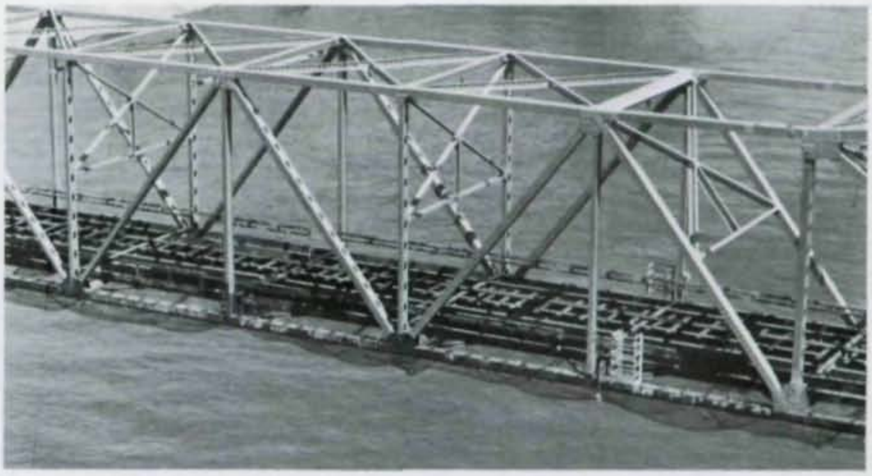
Unfortunately, East St. Louis did not have money for repairs; however, the Illinois DOT was willing to assume ownership of the bridge and finance the desperately needed repairs.

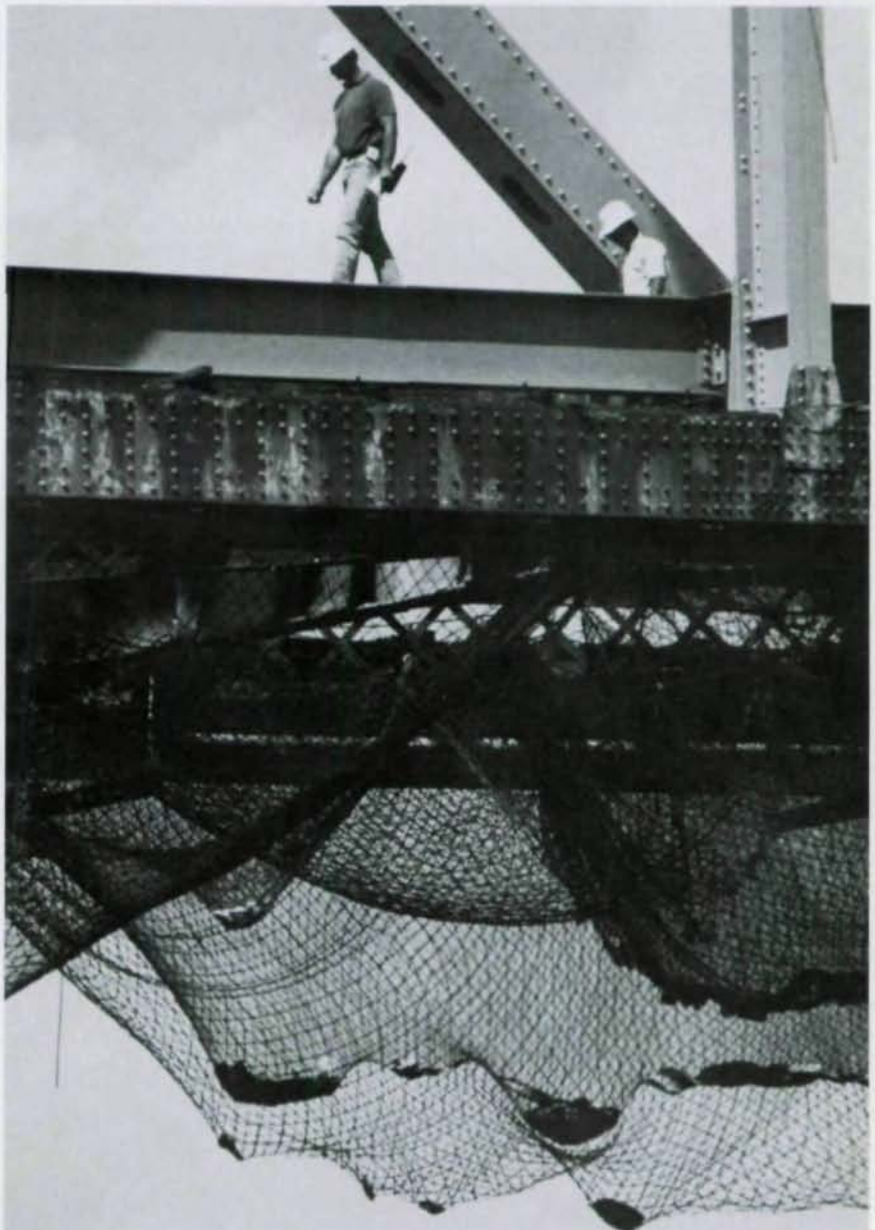
The renovation included: removal and replacement of the exterior stringers in every span and the removal and replacement of all stringers in the main span of the river bridge; removal and replacement of floor beams and strengthening of others where required; complete removal of five girder spans, including substructure units, and replacement with a new three-span, continuous welded plate girder structure, including new substructure units; complete removal of the existing bridge decks and replacement with new cast-in-place and concrete-filled steel grid decks; structural repair of substructure units; removal of all lead-based paint and replacement with a new coating system; and installation of new deck expansion joints.

The renovation involved the installation and repair of 1,530 tons of steel. Engineering began in September of 1986, with design completion in October 1987. The construction contract was awarded in January 1988, with construction commencing in April 1988 and being completed in may 1988.

The minimal construction time was accomplished through the use of detailed repair drawings. "Normally, rehabilitation designers provide generic instructions and quantities for making repairs," explained James K. Van Buren, vice president-T&PW, Sverdrup Corp., St. Louis. "However, the provision of precise details and specification allowed the fabrication and delivery of materials to be expedited."

The renovated structure, which is expected to last more than 50 years with normal operations and





proper maintenance, was upgraded from its original H20 designation (for 20-ton trucks on two axles) to HS20 (for semi-trucks with trailers on three axles with a total weight of up to 36 tons).

Problems and Solutions

- One potential problem during renovation was how to keep balanced loads on the bridge. "Removal of extensive amounts of concrete and steel from one end of the bridge causes the structure to become unbalanced and subject to possible failure," said Van Buren. To maintain load balance during renovation, construction materials were stockpiled on one end of the bridge while construction was occurring at the other end. Also, roller bearings at the abutments were replaced and new larger pins were installed.
- During the 1960s, the bridge's expansion joints had been paved over, causing the drainage troughs to be full of asphalt. As a result, structural steel, especially along the outside of the deck, was corroded by the combination of collected water and deicing salt brine. The solution was to create a new closed system on the approach spans to collect water and route it back to the municipal storm drainage system. The steel also was sandblasted and completely repainted with a four-coat system.
- As with any renovation work, demolition activity had to be carefully monitored to protect against falling debris. To protect barges and other river craft, the contractor provided an extensive netting system anchored beneath the bridge. Also, during sandblasting operations, a movable platform with a contained enclosure was mounted under the bridge to catch the sandblasted particles.

Design Innovations

One of the biggest challenges of the project was to increase the strength of the river bridge to accommodate the increased live load rating. The engineering team determined that the solution was to add weight to the steel truss approach spans but reduce weight in the main spans.

The original approaches were 6" slabs of reinforced concrete and the main span was a 4-1/2" steel grid filled with concrete. The entire deck was covered with a 1-1/2" layer of asphalt. The new approach span deck systems are composed of 8-1/2" slabs of concrete, while the main span decks were made up of a steel grid with only the top 2-1/2" filled with lightweight concrete. A waterproof membrane over the concrete protects the steel grid deck. The membrane is topped with a 1-1/2" layer of asphalt.

To save weight, lightweight aluminum parapets or Jersey-type safety barriers were specified. Also, high-strength bolts replaced rivets, providing increased strength with minimal weight gain. □

Vulcraft

Steel roof and floor decks have long been recognized for their economy because of their light weight and high strength-to-weight ratio. They provide a durable and attractive roof or floor system for fast all-weather construction. Steel decks also provide excellent lateral diaphragm action thus reducing the necessity for structural bracing and their incombustible nature assures architects, engineers and owners of excellent fire ratings. Vulcraft offers a complete range of steel decking accurately roll formed in varying configurations.

For more information, contact: Vulcraft, P.O. Box 100520, Florence, SC 29501 (803) 662-0381.

Verti-Line

A new line of metal decking, roofing and wall panels that provide the combined benefits of excellent aesthetics, design versatility and ease of installation has been introduced by N.A.T. Industries, Inc. Unlike conventional profiled panels with trapezoidal ribbing, Verti-Line panel ribs are fabricated to 90 degree angles, resulting in clean crisp lines that create interesting architectural relief and shadow effects. The company can vary the width of the reveal and/or the top pan to desired dimensions.

For more information, contact: N.A.T. Industries, Inc., 14213 Whittram Ave., Fontana, CA 92335 (714) 355-1919.

United Steel Deck

United Steel Deck, Inc., produces a complete line of floor, roof, and form deck products. And now, because of the addition of new braking equipment, USD can manufacture special deck sections to solve unique problems. Recent examples include: a non-standard depth form deck to carry a heavy concrete pour without shoring; ¼" plate formed into a ribbed heat shield; and a 12 gage canopy deck with a special paint finish. Estimates are furnished upon request.

For more information, contact: Nicholas J. Bouras, Inc., P.O. Box 662, 475 Springfield Ave., Summit, NJ 07901 (908) 277-1617.

Curveline

Curved metal decking is the specialty of Curveline, Inc. For example, the company recently undertook a massive project for the new Virginia Air and Space Center and Hampton Roads History Center. An exposed metal decking system was curved to conform with massive arched trusses that ranged from 84' to 130' long and extended 120' into the air. The project included more than 800 "B" deck panels of 20 gage galvanized steel from Bowman Metal Deck that were "crimp-curved" by Curveline. The project was designed to look like the wings of a seagull in flight, and steel decking was chosen because of its weight advantage compared with concrete decking.

For more information, contact: Curveline, Inc., P.O. Box 4628, Ontario, CA 91761 (714) 947-6022.

Epic Metals

Epic Long Span Deck is combination roof and ceiling panel capable of spanning more than 30' between supports. The top surface is ready for standard rigid insulation and roofing, while the underside becomes a finished ceiling ready for decorator colors. The ceiling may be fluted (E) or flush (EP), plain, or perforated/arcaded for permanent acoustical treatment. The ceiling also may serve as a means of distributing hot/cold air, electrical supply, radiant heat or recessed lighting. Depths vary from 4½" to 7½", with design thicknesses up to 14 gauge. The product features a unique side joint that locks panels together along their entire length. From below, the exposed surface presents a uniform ceiling with no irregular gaps.

For more information, contact: Robert Paul, Product Engineer, Epic Metals Corp., Eleven Talbot Ave., Rankin, PA 15104 (412) 351-3913.

Steel Deck Institute

An updated *Diaphragm Design Manual* is available from the Steel Deck Institute. This easy reference provides information on diaphragm strength, diaphragm stiffness, connections, concrete-filled diaphragms, fastener layout, and warping factor development. It also provides 62 pages of shear diaphragm examples and a complete guide to symbols and references. The Second Edition is available for $45, while the First Edition costs $30 and the *Steel Deck Design Manual* costs $11.

For more information, contact: Steel Deck Institute, P.O. Box 9506, Canton, OH 44711 (216) 493-7886.

Klemp Corporation

Riv-Dexteel is a lightweight metal decking for roadways. Introduced almost 65 years ago, the product provides a maintenance-free roadway under the most adverse traffic conditions over long periods of time. The comparatively light weight of metal grating compared to other surfaces makes it ideal for movable bridges. Its light weight also frequently allows bridge widening without an appreciable increase in bridge weight. And it allows resurfacing to handle heavier loads without expensive substructure work. And it's ideal where flooding, snow buildup or icing is a potential problem since its openness helps reduce the pressure normally exerted against a solid surface.

For more information, contact: Klemp Corp., 1132 W. Blackhawk St., Chicago, IL 60622.

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Eric K. Nieman
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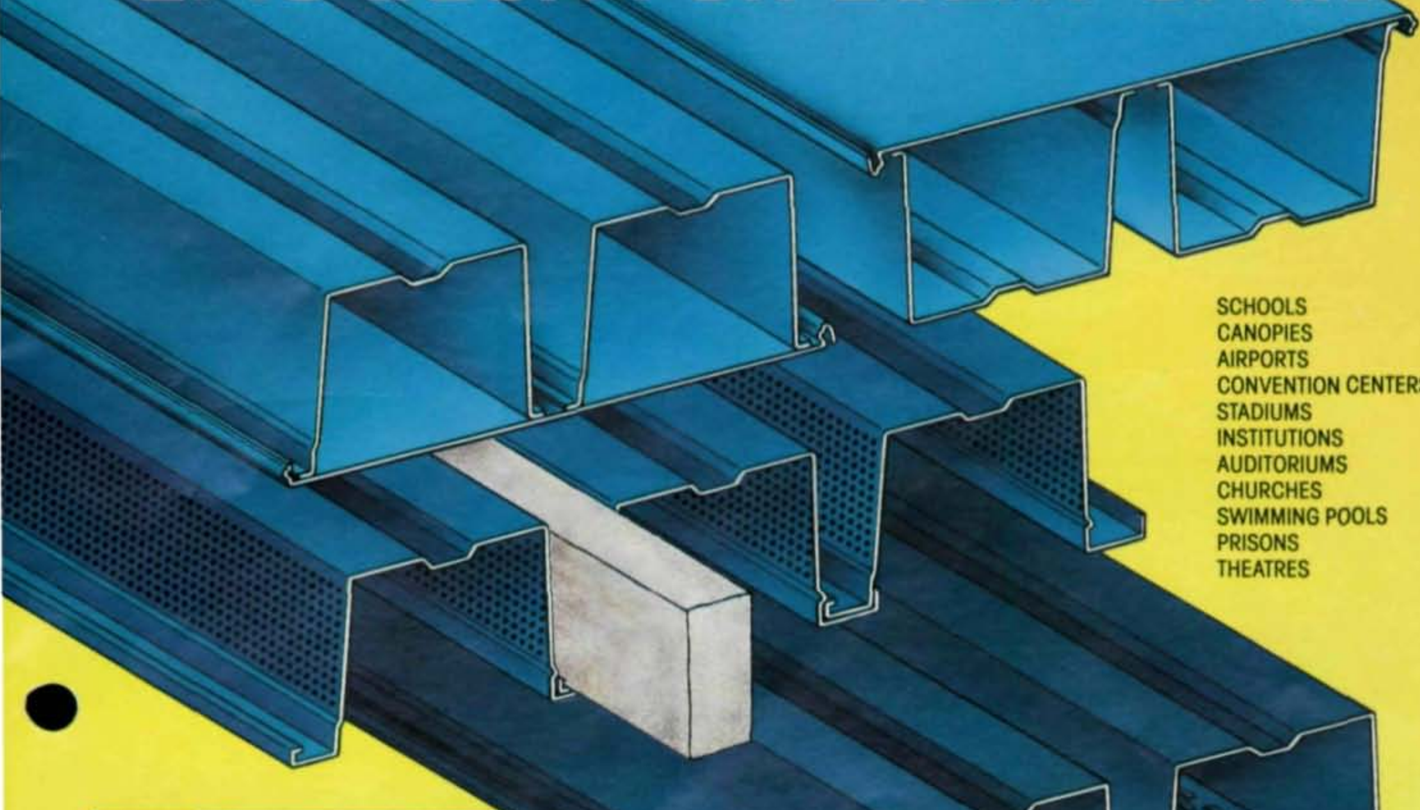

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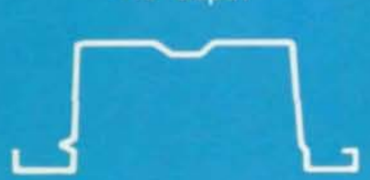
4½" depth



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- Wide choice of depths and design thicknesses
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- Blend control—use acoustic and non-acoustic panels together

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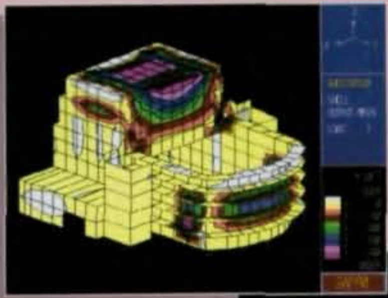

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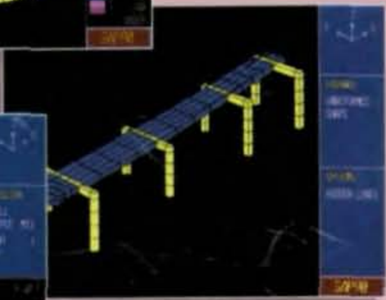

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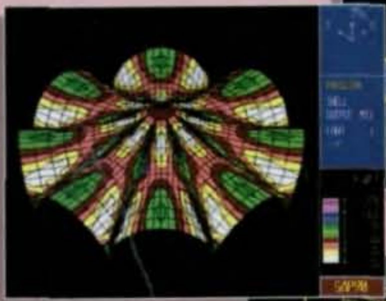

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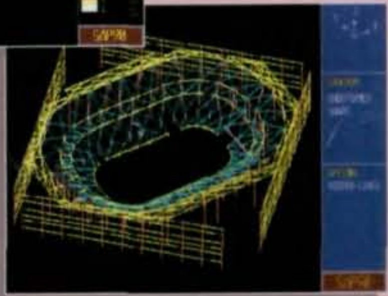

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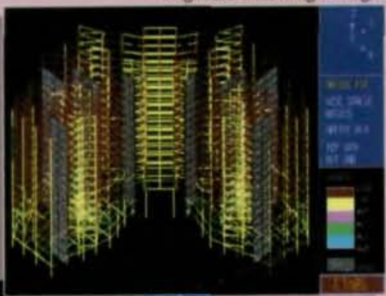

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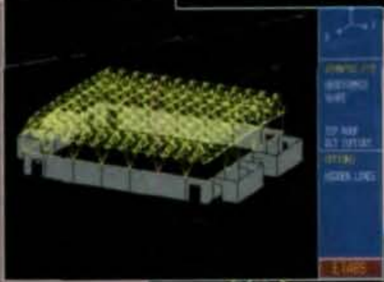

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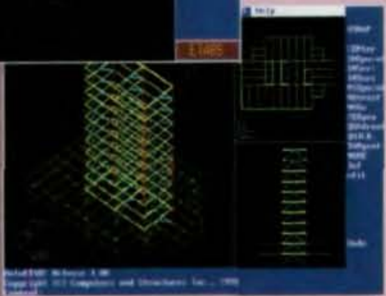

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