AMERICAN INSTITUTE OF STEEL CONSTRUCTION
One East Wacker Drive
Chicago, Illinois 60601

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MODERN STEEL CONSTRUCTION

NUMBER 6 • 1989

THIS ISSUE

UNITED STEEL DECK, INC.

DECK DESIGN DATA SHEET
No. 13

DECK FINISHES

STANDARD FINISHES COMMONLY AVAILABLE ON USD PRODUCTS

PRODUCTS	GALV. G90 or G60 I.	PHOS/PTD II.	PRIME PTD III.	GALV. + PAINT IV.	FINISH PAINT V.	UNCOATED VI.
1½" & 3" Roof Decks	X		X	X	X	
4½", 6", 7½" Roof Deck	X					
1½", 2", 3" Composite Deck	X	X				
UFX36, UF2X, UFS (Form Deck)	X			X	X	X

THE TABLE REPRESENTS NORMAL INVENTORIES; HOWEVER ANY FINISH ON ANY PRODUCT MAY BE AVAILABLE ON SPECIAL ORDER.

NOTES — ROMAN NUMERALS IN THE TABLE CORRESPOND TO NUMERALS IN NOTES.

I. A. CHECK U.L. FIRE RESISTANCE DIRECTORY FOR FINISH REQUIREMENTS. GALVANIZED DECK SHOULD BE USED ON *ROOF* CONSTRUCTION WITH SPRAYED FIRE RESISTIVE MATERIALS. (SFRM).
B. GALVANIZED DECK IS RECOMMENDED FOR HIGH HUMIDITY AREAS.
C. GALVANIZED ROOF DECK IS RECOMMENDED FOR ROOF CONSTRUCTIONS WITH INSULATION BOARDS THAT ARE FASTENED TO THE DECK WITH PIERCING FASTENERS.
D. USD RECOMMENDS THE USE OF GALVANIZED MATERIALS FOR MOST EXPOSURES.
E. GALVANIZED STEEL IS COVERED BY ASTM A446; GALVANIZING IS COVERED BY ASTM A525; G60 AND G90 ARE COATING WEIGHTS.

II. A. "PHOS/PTD." MEANS THE FLOOR DECK IS ONLY PAINTED ON THE EXPOSED SIDE—THE CONCRETE SIDE SHOULD DEVELOP TIGHT RUST BEFORE THE CONCRETE IS POURED.
B. USE ONLY FOR INTERIOR APPLICATIONS—I.E. OFFICES OR HOTELS.
C. CHECK U.L. FIRE RESISTANCE DIRECTORY—SEE NOTE I.A.
D. "PHOS./PTD." IS APPLIED TO ASTM A611 STEEL.

III. A. "PRIME PAINTED" MEANS A PRIMER COAT OF PAINT IS APPLIED OVER CLEAN BARE STEEL. THE PRIMER PAINT IS FORMULATED TO HAVE "TOOTH" TO HOLD SUBSEQUENT APPLICATIONS OF FINISH PAINT BUT IT IS NOT INTENDED TO PROVIDE EXTENSIVE WEATHER PROTECTION; IT IS FREQUENTLY LEFT EXPOSED IN WAREHOUSES AND MANUFACTURING PLANTS, AND WHEN USED WITH SUSPENDED CEILINGS.
B. USE FOR BALLASTED ROOFS OR ADHERED ROOF SYSTEMS— SEE NOTE I.C.
C. SALT SPRAY (AND OTHER) TEST RESULTS ARE AVAILABLE ON REQUEST.
D. "PRIME PAINTED" DECK IS MADE FROM ASTM A611 STEEL.

IV A. "GALV. + PAINT" MEANS PRIMER IS FACTORY APPLIED OVER GALVANIZED STEEL. THE PRIMER PAINT IS AS DESCRIBED IN III.
B. THIS FINISH IS MOST ECONOMICAL WHEN A FINAL COAT OF PAINT IS TO BE FIELD APPLIED.
C. USE IN HIGH HUMIDITY AREAS—THE PAINT PLUS GALVANIZING PROVIDES EXTREMELY GOOD MOISTURE PROTECTION.
D. "GALV. + PAINT" USES ASTM A446 STEEL.

V. A. FINISH COATS OF PAINT CAN BE FACTORY APPLIED. THIS IS DONE ON THE COILS OF STEEL BEFORE FORMING INTO DECK. ALMOST ANY COLOR OR PAINT TYPE CAN BE USED—HOWEVER TO BE ECONOMICAL, THE ORDER SHOULD BE FOR AT LEAST 20,000 SQUARE FEET.
B. WHEN INSTALLING DECK WITH A SPECIAL FINISH, SCREWED SIDE LAPS ARE RECOMMENDED: AND, IN MOST CASES, SCREWS, PNEUMATIC OR POWDER DRIVEN FASTENERS SHOULD BE USED AT SUPPORTS.
C. FINISH PAINT IS NORMALLY APPLIED OVER GALVANIZED STEEL CONFORMING TO ASTM A446.

VI. A. UNCOATED STEEL MEANS THERE IS NO COATING AT ALL. IT IS FREQUENTLY REFERRED TO AS "BLACK" STEEL.
B. UNCOATED STEEL CONFORMS TO ASTM A611.

NICHOLAS J. BOURAS, INC.
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ANNOUNCING
"TAKING STEEL CONSTRUCTION INTO THE XXIst CENTURY"
The Breakthrough

MODERN STEEL CONSTRUCTION

VOLUME XXIX • NUMBER 6
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American Institute of Steel Construction, Inc.

One East Wacker Drive
Chicago, Illinois 60601
Phone: 312 / 670-2400

ON OUR COVER

Dramatic new West Point Visitors Center Opens. See p. 9.

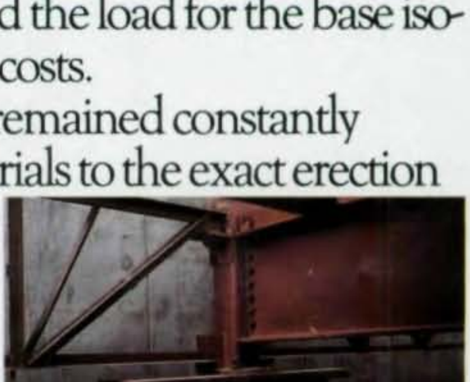
AFE FROM EARTHQUAKES
MPANIES THE SHAKES.

That was essential because the building, which was constructed for Evans & Sutherland Computer Corporation, is located within a mile of the Wasatch Fault in Salt Lake City. What's more, Evans & Sutherland is a leading designer of special-purpose digital computers, software systems and display devices —

products extremely vulnerable to damage from seismic tremors.

To plan for maximum protection, Vulcraft was asked to join with the architects and engineers at the design stage of the project. Already, they'd decided to use a "base isolation" system, the most advanced buffering method available. But using our steel joists and joist girders was also an important decision. The joists and joist girders are much lighter in weight than wide flange beams, so the entire building required less steel, lighter columns and less foundation. And this not only lightened the load for the base isolators, it saved appreciably on building costs.

Throughout construction, Vulcraft remained constantly involved, tailoring our delivery of materials to the exact erection schedule and meeting deadlines without fail. What's more, our joists and joist girders helped the steel erectors meet their deadlines. That's because our products are fast and easy to erect — a fact that saves time and money on virtually any job where they're used.



The design team chose a "base isolation" system to accommodate seismic loads. They also specified Vulcraft steel joists and joist girders for the building.

So whether you need Vulcraft's help to protect your building from earthquakes or you want to stay out of the hole when it comes to construction costs, contact any of the plants listed below. Or see Sweet's 05100/VUL.

VULCRAFT
A Division of Nucor Corporation

P.O. Box 637, Brigham City, UT 84302 801/734-9433; P.O. Box F-2, Florence, SC 29502 803/662-0381; P.O. Box 169, Fort Payne, AL 35967 205/845-2460; P.O. Box 186, Grapeland, TX 75844 409/687-4665; P.O. Box 59, Norfolk, NE 68701 402/644-8500; P.O. Box 1000, St. Joe, IN 46785 219/337-5411. Architect: Erlich-Rominger Architects AIA; Structural Engineer: Reaveley Engineers & Associates, Inc.; General Contractor: The Bettilyon Corporation; Steel Fabricator: D&H Steel Supply, Inc.; Steel Erector: Steel Deck Erectors, Inc.

Creative Design

WEST POINT VISITORS CENTER

A New Gateway to History

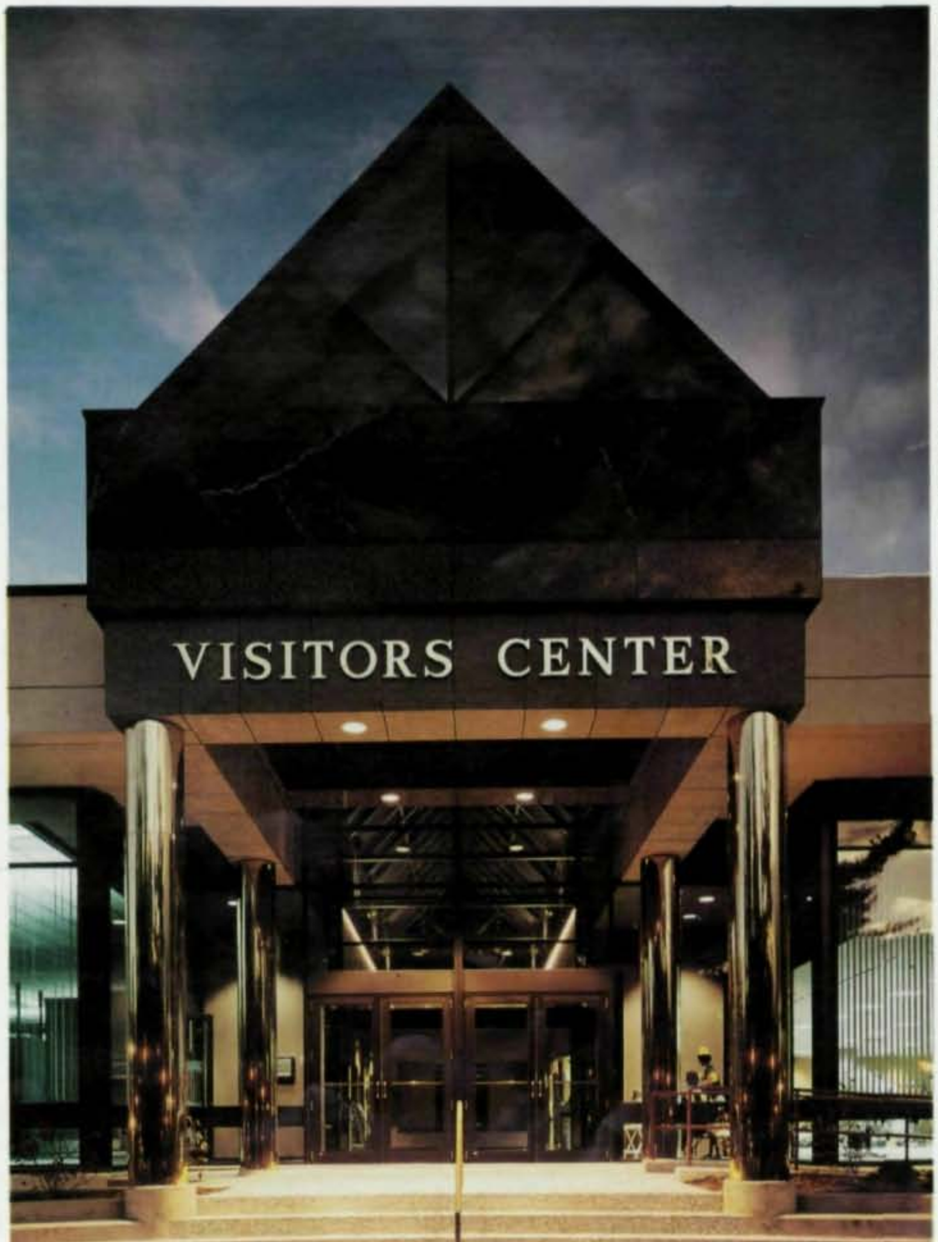
by Maria Valenti

Conquering challenges and solving problems is a way of life for cadets dedicated to "duty, honor and country" at the U.S. Military Academy in West Point, N.Y. The same spirit of creative resolution helped architects JSA Inc. successfully conclude a difficult mission at the Academy.

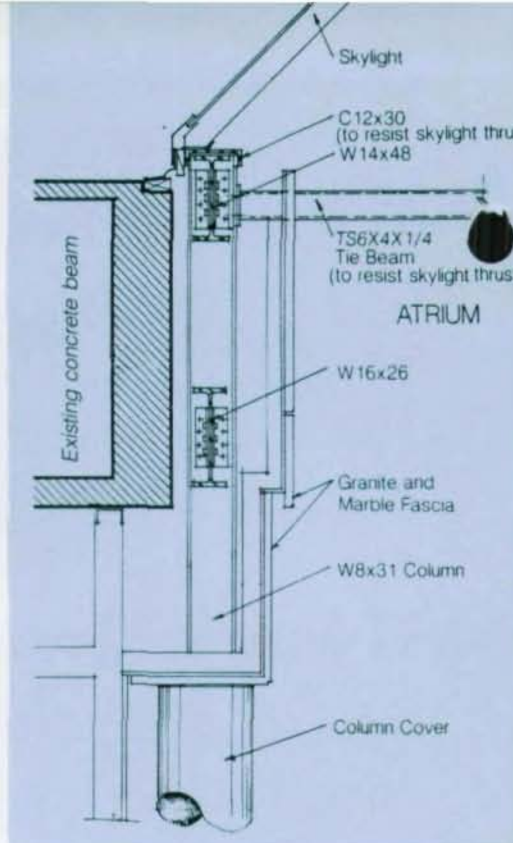
The New Hampshire-based architectural and planning firm was charged with designing an expansion to the West Point Visitors Center which would reflect the Academy's dignity and history, but which could be constructed for a predetermined price and within a fast-track time frame. A number of other restrictions and requirements were placed on structure and design by the Army Corps of Engineers.

The project is the centerpiece of both new construction and renovation work on the Academy's "New South Post" campus, acquired from the former Ladycliff College. It included an addition of a gift facility directly adjacent to the existing Visitors Center. A central atrium joins both structures and serves as a common entrance. Furthermore, the facade of the new gift facility replicates the Visitors Center building (a former library) and the new entrance and plaza creates an overall entrance identity to the complex. The project's completion marked the recent official opening of the New South Campus.

The central challenge, according to JSA partner and principal in charge of the project Jim Warner, was, "How do you design a building that can be built in a few months that looks exactly like an adjacent existing



Architectural photos by Bruce T. Martin Photography



Looking down axis of atrium toward entry shows separation of skylight and existing building. Drawing (r.) details juncture.

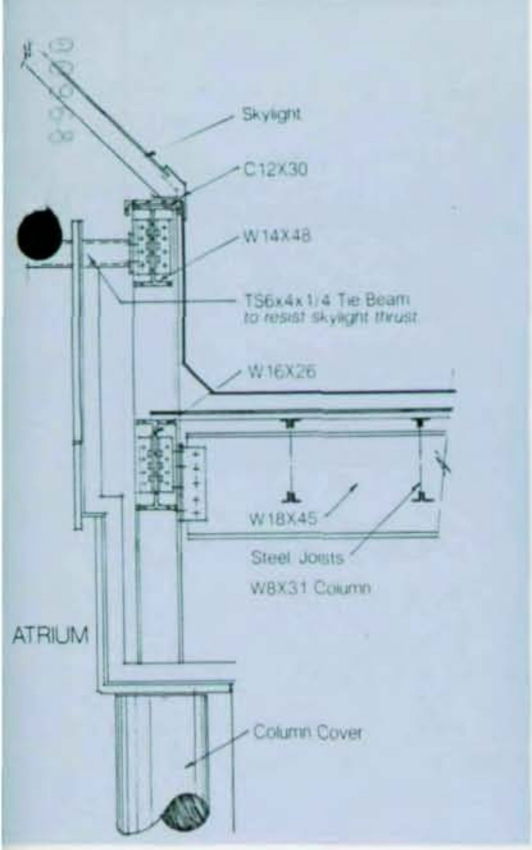
concrete building, but is made of less expensive and easier to erect materials?"

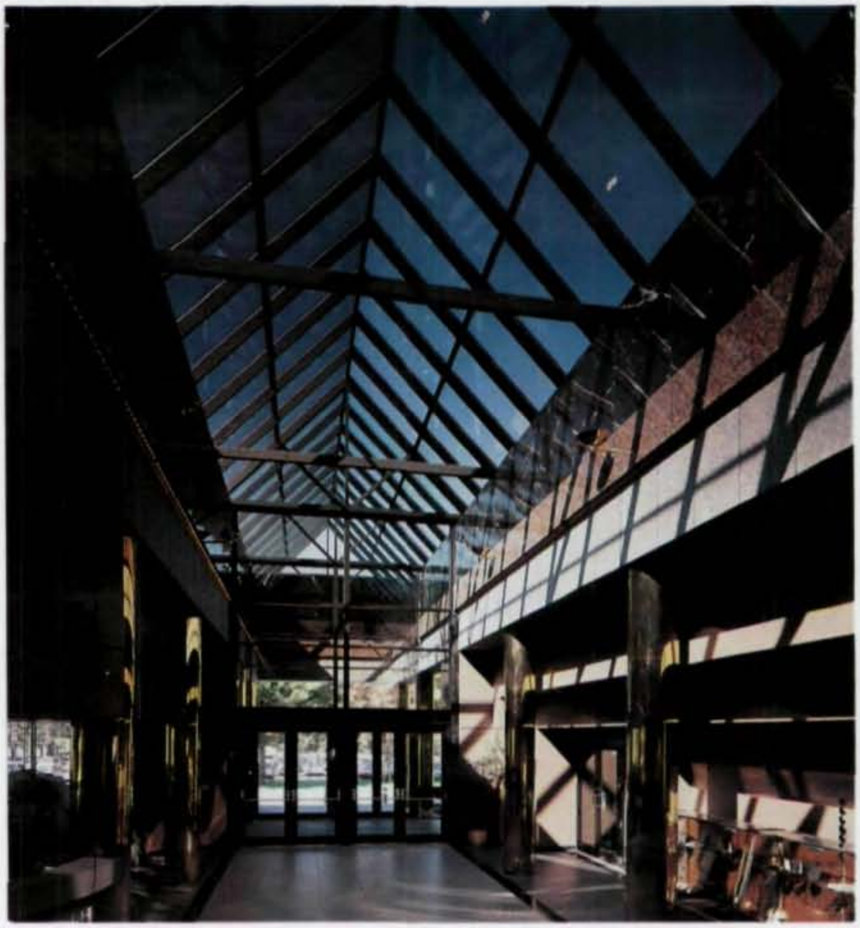
Specific restrictions in the Request for Proposal (RFP) issued by the Army Corps of Engineers included a prohibition on any structural connection to the existing Visitor's building—and even that the colors used must be Academy black, grey and gold.

Steel Meets the Challenges

Steel was selected as the material which would help the architects meet the design, cost and time demands of the RFP. Structure began to influence form as the JSA team, led by project architect Michael Tague, worked to satisfy the criteria and schedule set forth. For example, the use of structural steel columns to support the atrium skylight, while fulfilling the condition of not tying into the Visitor Center, helped shape the design of the 30-ft high glass atrium/entranceway.

According to Tague and consulting engineer Tim Shelley of Neill and Gunter, Inc. of Maine, steel tube ties were included in





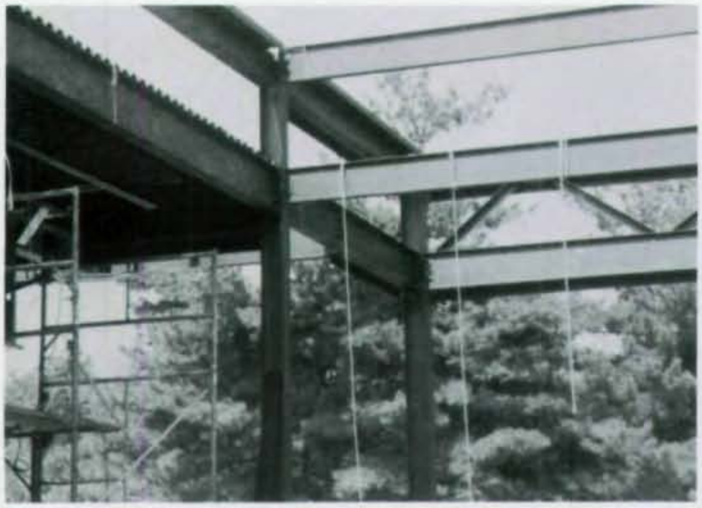
the atrium design to prevent the thrust of the skylight from kicking out into the existing building. The skylight structure was designed to also support the mechanical unit hidden in the skylight framing. "We just left the glass off of the rear part," said Tague.

Other existing conditions affected design details. "The concrete building we were trying to match had only four concrete columns in the whole building, supporting 60-ft span joists. We had to create a building that looked the same from the outside, but with steel. Obviously, we were not going to do it with only four columns," said Shelley.

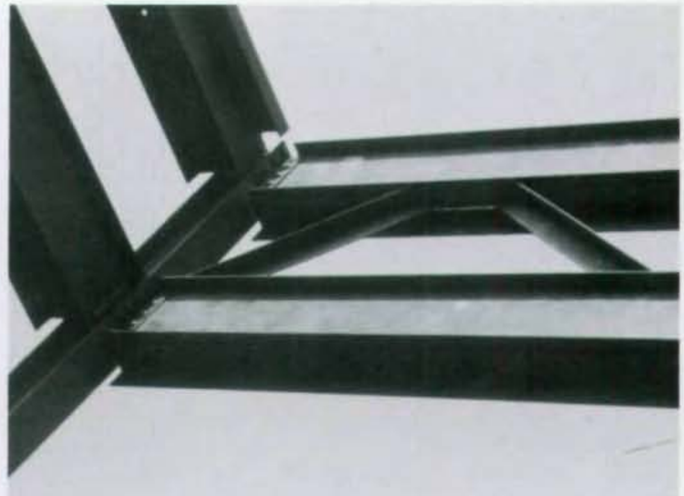
The solution was a steel 30-ft by 30-ft bay grid using 18 steel W10 columns which would be, according to Shelley, "perfect for the almost 90-ft by 90-ft space."

As the design progressed, other challenges regarding the steel structure arose. "We had to revise our preliminary structural design since it had been based on moment connections," said Tague. "When the construction budget was revealed after we were awarded the design, we discovered the job had been estimated based on using traditional bracing, not moment connections."

(continued)



Tie beams at entry and C12x30 on top of wide-flange beam resists skylight thrust.



Detail of end steel truss and side beams. Bottom beam carries roof structure.

Flexibility for Design and Tradition

One of the design dilemmas at this point involved concealing the bracing, since a good part of the facade is glass, according to Shelley. "JSA hid the bracing behind spandrel glass, saving both time and money," he said.

The use of steel provided solutions to other problems, as well as infuenced a number of design decisions. It helped satisfy the requirement to match the existing building's five-foot cast-in-place concrete fascia overhang by enabling the architect to design the structure with cantilevered beams to catch precast glass fiber reinforced concrete panels.

Conversely, the bearing capacity of steel vs. concrete influenced the materials used on the entrance facade. To save weight, as well as delivery time, ¼-in. red-and-black granite and black marble face panels, backed by one-in. aluminum honey-comb backing, were used on the entrance canopy instead of dimensional stone. Steel also provided the interior sturcture for the four, 20-in. polished brass columns that preside over the granite plaza and provide a grand entrance for the tens of thousands of visitors who tour West Point each year.

"Steel afforded us the flexibility we needed to conform to certain traditional design aspects of the existing building," said Warner, a West Point graduate, "as well as the flexibility to incorporate contemporary elements such as the glass skylight."

George Liadis, of Trataros Construction, agreed that steel played an important role in the successful execution of the project. "Timing was everything on the job," said Liadis, who noted that heavy spring and summer rains created job delays which had to be made up by working nearly nonstop from May through to the September deadline.

Warner went on to note that administrating the West Point project on a design/build basis was a departure from the norm for the Army Corps of Engineers, and was done so because of a more entrepreneurial approach being attempted by the Department of Defense on many of its construction projects. "The traditional course is that an architect is engaged to design a job, and then the job is put out for bid. This project would never have been completed in time if that route had been taken."

In fact, due to a certain amount of inevitable bureaucracy, the project fell behind before it even got off the ground. "We told them we needed 270 days to complete the job," said Liadis. "Although we received the contract in October, 1988, we didn't get the approval to proceed until March 17, 1989. Luckily, the steel erection went smoothly. Other material delays, like the skylight and honeycomb panels, had us working up until the last minute, though."

According to Liadis, the use of steel helped conclude the job in about half the estimated time. "The grand opening ceremony took place on schedule, Sept. 1," he said.

All involved agreed that a sense of history pervaded the project from start to finish. "West Point has a spectacular campus on the Hudson River," said Warner. "The Visitors Center is the gateway to the area."

"It was a prestigious job," said Tague. "The use of steel helped make it a success." □

Architect
JSA Inc. Architects Planners
Portsmouth, New Hampshire

Consulting Engineer
Neill & Gunter, Inc.
Portland, Maine

General Contractor
Trataros Construction, Inc.
Brooklyn, New York

Steel Fabricator
McKinney Steel
Albany, New York

Owner
United States Military Academy
West Point, New York

Fast-track job. Steel framing helped finish project in about half of estimated schedule.

Maria Valenti is free-lance writer living in Westborough, Massachusetts.

THE SPORTING CLUB AT THE BELLEVUE

Steel Solves a "Weight" Problem

by Walter E.B. Jewell

A "weighty" problem was solved by using steel framing on sports club atop Bellevue parking deck.

In 1980, the owners of Philadelphia's Bellevue Hotel constructed a 350-car garage adjacent to a 20-story office building and separated from the hotel by 20-ft wide Chancellor Street. At the time, the owner's program called for a reinforced concrete structure with post-tensioned slabs. During the design, the owners felt assured they would complete negotiations for a tenant to lease a 45,000 sq. ft health club to be constructed above the garage.

Because the foundation design required caissons to rock, and strap grade beams to support exterior columns, the owner chose not to design extra capacity into the structure. When negotiations were terminated, construction stopped at the last parking level. Over the next several years, other clubs were solicited. Some of these deals could not be completed because of the inherent limited capacity of the completed parking structure.

In 1986, the owner negotiated with the Naiman Company of San Diego, Cal. to study the possibility of finally constructing a health club above the garage. From the onset, it became apparent that a program to satisfy them would include far more than the 45,000-sq. ft, two-level health club facility as originally planned. After several studies to determine the amount of new loads to be imposed, it became evident that completion of the building as originally designed was impossible under existing conditions.

To compound the problem, the owner had begun to refurbish the Bellevue Hotel and to convert it from a luxury historic Center City Hotel to a gallery of shops and offices, with a high-class smaller hotel on the upper floors. For this construction, it was necessary to close Chancellor Street for the temporary exclusive use of the contractor. It became apparent the only possible way to construct the building was to change the building materials—to a structural steel frame to allow a less expensive, lighter construction system.

Because the original parking structure required columns at 62 ft o.c., it became necessary to use either deep beams at every floor or to construct a transfer system. From preliminary pricing by the construction manager, it was determined the building would have 10-ft deep trusses spanning from exterior to interior columns and these would support 30-ft long purlins using a composite steel section with 2-in. metal deck and a 4¼-in. lightweight slab.

As the architect and Naiman Company project manager continued to develop their program, more and more square footage became necessary. Because the columns and foundations were designed for specific locations of pools, weight rooms and other public areas of the originally envisioned club, a constant shifting of areas was needed to impose the most balanced new loading to the existing columns and foundations. In the end, the use of structural steel permitted almost 85,000 sq. ft of new construction to be built 85 ft high instead of the original 45,000 sq. ft at 50 ft high. The design was complicated by the need to distribute the vertical loads to the columns where the most reserve capacity existed. Both gravity and lateral loads through the building had to be transferred around the large open areas at the gym with raised running track, the pool, the basketball courts and other high-ceiling areas.

Design Only Part of Problem

Design, however, was only part of the major problems this building faced. There were economic and construction limitations. The fact that Chancellor Street was no longer available, meant that the majority of the structural steel would be erected from Broad Street, Philadelphia's major north/south thoroughfare. In addition, the Broad Street subway line and pedestrian concourse are directly beneath the street and sidewalk in front of the structure, creating potential hazards in the location of cranes.

The erection of the four-story structural steel frame on top of the existing seven-level parking garage of the Bellevue Hotel took on a complete new degree of difficulty when the owner informed the erector the storage area for cranes and material storage on Chancellor Street was no longer available. Joseph Cooke, the structural engineer for the entire project, designed 18 10-ton trusses 50 ft long to support the upper four floors and running track. The erector put in place six trusses from Locust Street and twelve trusses from Broad Street on two weekends.

After completing the framing at the truss level, a 5-in. concrete slab was poured on 24,000 sq. ft of 20-ga. metal deck. Two 30-ton cranes were raised to the new slab area with a large crane working off a wood-matted cover over the subway which was approved by Septa Engineers. The cranes were supported on a double 30-in. beam runway on 12 × 12 oak timbers 10 ft long. The runway ran from Broad Street west for

220 ft. Inside the runway beams, a dolly railroad was built to transport the unloaded material to the existing crane at the west end of job. About six tons of material could be moved at one time manually with relative ease in about five minutes.

In about five weeks, the steel structure was about 70% erected, and one crane had worked itself out of a job. So the east end crane was lowered to Broad Street, leaving the second crane to both unload and erect the balance of material, which included the miscellaneous steel for the pool and running track.

Despite all of the special considerations given, it is estimated that the project saved $500,000 and six months over a concrete building. More importantly, the use of structural steel made this project feasible. Had it not been converted to steel, we might still be waiting to find the health club promoter who could live with 45,000 sq. ft of space. ☐

Walter E.B. Jewell is a consultant with the AISC Member steel fabricator firm of Leonard Kunkin & Associates, Line Lexington, Pennsylvania.

Exterior of sporting club above parking deck of adjacent hotel.

Architect
Michael Graves
Princeton, New Jersey

Structural Engineer
Joseph W. Cooke Associates
Philadelphia, Pennsylvania

General Contractor
Turner Construction Company
Philadelphia, Pennsylvania

Steel Fabricator
Leonard Kunkin & Associates, Inc.
Line Lexington, Pennsylvania

Owner
Bellevue Hotel
Philadelphia, Pennsylvania

LAMBERT AIRPORT BRIDGE

Sharpest Curve in the Midwest!

by Josephine L. Emerick

Sharp sweep of Ramp D girders (l. and above) show ingenious use of steel.
Photo courtesy Delong's, Inc.

Elevation looking southeast, with Ramp A in background.

Lambert-St. Louis International Airport is a busy place, both in terms of air traffic and airport construction. Part of this new construction includes a multiple ramp bridge project, which features what is believed to be the most highly curved steel bridge in the Midwest.

Lambert is the seventh busiest airport in the nation, with 280,092 flights by commercial air carriers in 1987, and ranks 10th in the world in the number of landings and takeoffs.

Figures for 1987 indicated there are 811 commercial flights and 244 commuter flights each day. That means, in favorable weather conditions, approximately 75 flights take off and land every hour. Eleven major airlines serve the field. Along with the growth of air traffic at Lambert has come a tremendous volume of renovation and new construction. The number of gates at the airport was increased significantly in 1985 when the East Terminal wing was opened. And recent renovation to access roads, the rental car return area, and parking facilities has helped ease traffic congestion around the airport.

Lambert has received $90 million in federal improvement grants since 1981 (more than any other airport in the nation), and plans to invest $130 million in the next five years on improvements to the airfield, the terminal, roadway access and a noise mitigation program.

Booker Associates, Inc., a St. Louis-based multi-disciplinary engineering firm, has provided highway design and consultant services to the Lambert-St. Louis International Airport Authority since the beginning of the major improvements program in 1979. Part of the firm's involvement at Lambert has been the conceptual and engineering design for the reconstruction of the collector distributor roadways. Most recently construction was Phase II, which included the rebuilding of the direct connections to the terminal and the parking garage, south and southeast of the terminal.

Part of this Phase II work involved the design of a multiple ramp bridge to carry vehicles smoothly onto the ticketing/check-in level of the main terminal area and into the rental-car ready area on the lower level of the parking garage. The design required an indepth analysis of traffic patterns and the construction phasing necessary to facilitate traffic handling. A key issue engineers had to address was how to minimize disruption to traffic flow in and out of the airport during the project. Fred Weber, Inc. was awarded the contract for the Phase II Roadways Project, including the multiple ramp bridge. The structural part of this project is one ramp that splits into two ramps, with a length of 564 feet and weighing in at 359 tons.

Ramp A, serving traffic from the east, has a 382-ft radius, and Ramp D, serving traffic from the south and west, has a 150-ft radius. If Ramp D were continued on, it would make a complete circle around the ends of a football field. And both ramps are on vertical curves, in addition to their horizontal curves.

One of the big girders, A22, is 75 ft-7 in. long and weights 29,907 lbs. Top and bottom flanges are plates 22 in. wide by 2 in. thick. The web is ½ in. thick, with a 4 ft-2 in. horizontal sweep and 1 13/10 ft vertical camber.

F. Joe DeLong III, president of DeLong, Inc., believes that Ramp D and its girders have the greatest degree of curvature of any steel bridge in the Midwest. It is the most highly curved of all of the thousands of plans bid upon or built by his firm in its 44-yr. history.

According to DeLong, the horizontal curvature in the girders was obtained by using continuous heat from two torches on each flange. The heat was applied to each flange simultaneously while the girder was in a horizontal position. Heat was applied to the section of the flange in compression and was closely monitored to insure the steel would not exceed 1,150° F.

Multiple passes with the torches were required on most girders. Steel was allowed to cool to normal temperatures before heat was applied again. Horizontal curve offsets were checked on each girder after heating (and cooling), and again on the complete stringer line when it was assembled for drilling the splice holes.

The design of the large degree of curvature was mandated by existing site conditions, because of the location of an existing parking garage and the layout of access roads and the major interstate that serves the airport. Booker engineers designed the bridges around these physical restrictions, and the firm's landscape architecture department assisted in the selection of a paint scheme and modified hammerhead piers to match existing conditions. □

Architect/Structural Engineer
Booker Associates, Inc.

General Contractor
Fred Weber, Inc.

Steel Fabricator
Delong's, Inc.

Owner/Construction Manager
St. Louis Airport Authority

Josephine Emerick, P.E., is section chief, Traffic and Transportation Section, Booker Associates, St. Louis, Missouri.

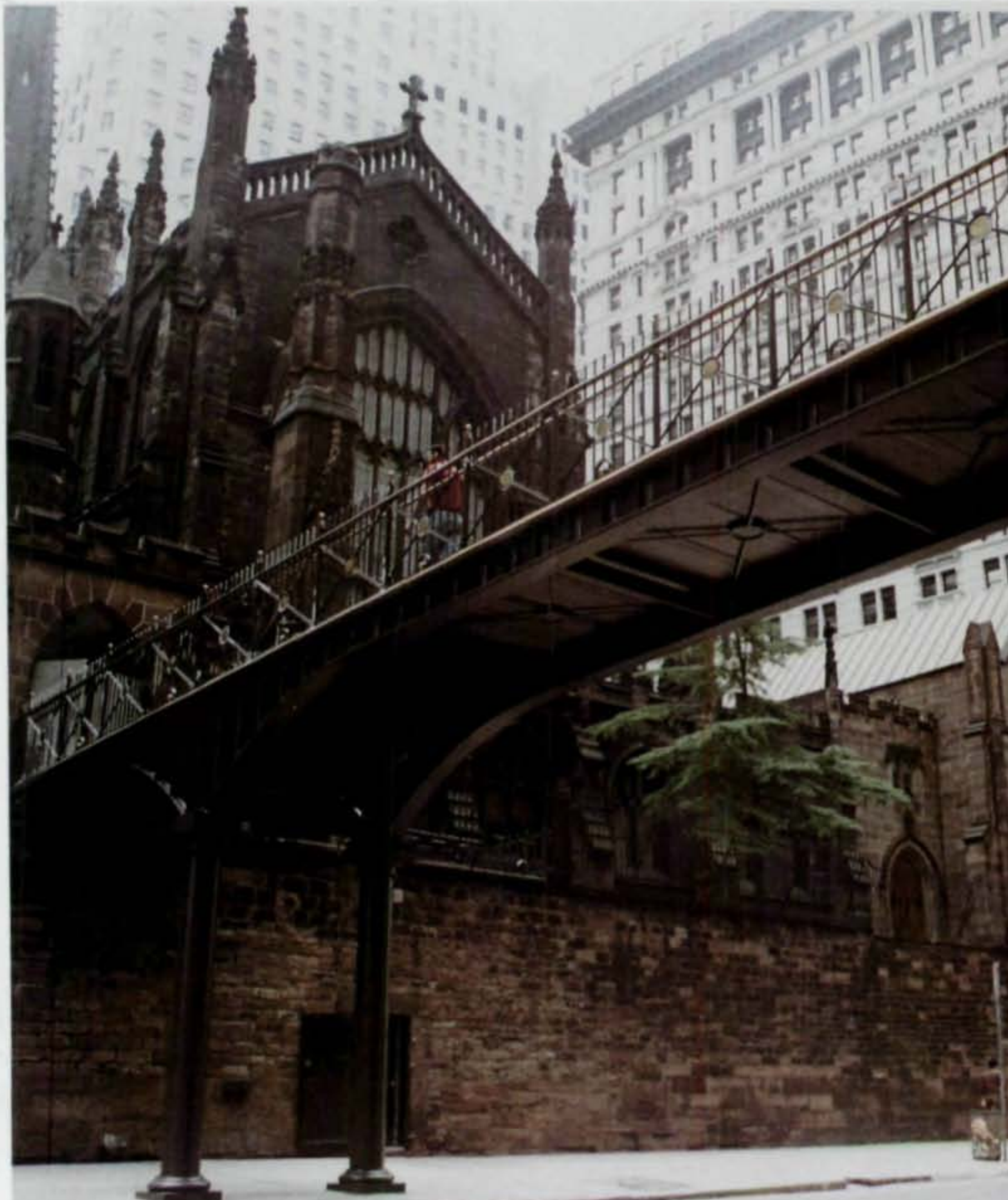
Fast Construction—with Steel

TRINITY CHURCH PEDESTRIAN BRIDGE

It Wasn't There Yesterday!

by Edward Cohen

The Trinity Church Pedestrian Bridge connects the Gothic portico at the rear of the church in lower Manhattan with the second floor of the 25-story building at 74 Trinity Place across the street. It houses the parish headquarters, clergy and staff offices, meeting rooms, classrooms, a cafeteria and dining facility and a preschool nursery. The structure is also a visual symbol linking the church edifice at the head of Wall Street to the site of its operating programs. The Parish of Trinity Church in New York City was chartered in 1697 by King William III of England, with the present building being the third church edifice to occupy the site. Because Trinity Church is a New York City landmark, the bridge's design could not compromise the church's historical integrity. It was also subject to the approval of the Landmarks Preservation Commission as well as 11 other city agencies and community groups, a process that took several years to achieve. In addition, since the bridge is located in a very congested area, its construction could not interrupt the normally heavy vehicular and pedestrian traffic on busy Trinity Place.



Aesthetic Studies

Trinity Church is probably the city's most famous church, and certainly its most dramatically situated. Completed in 1846, it was designed by Richard Upjohn in the delicately detailed, soaring Gothic Revival Style. Even today, the church holds its own in the congested Financial District of the city, and its graceful spire overlooks one of the most lovely churchyards anywhere.

The church is known for its extensive community programs. A dozen years ago, concerned for the safety of the mothers,

Loew Bridge (circa late 1880s) provided design concept for Trinity Bridge.

Finished steel bridge joins Trinity Church with Trinity Place across busy thoroughfare.

children and the elderly who participate in its activities and who daily had to cross increasingly busy Trinity Place, the church fathers decided to construct the footbridge.

A clue for the design (and approval of the Landmarks Commission) came from a historical precedent: the 1866 Loew Bridge at Saint Paul's Chapel. The bridge was built to protect pedestrians at the hazardous intersection of Broadway and Fulton Street. Loew Bridge was described in one construction publication as a fascinating early venture in New York construction and traffic engineering. The solution came through the design of a lacey, graceful, flat-arched open metal structure coated a charcoal brown color that spans the street, cantilevers over the historic stone retaining wall above Trinity Place and gently reaches the church through an existing porch and Gothic arch.

The architectural design of the bridge was finally approved by all the city agencies involved for two principal reasons. First, as stated previously, there was a precedent of a bridge in the area by thorough documentation about the nearby Loew Bridge, long since taken down. The other main reason is that the new design was felt to compliment—in fact, complement—the 143-year-old church and the 50-year-old parish building. Perhaps the nature of the bridge was best expressed by the Landmarks Preservation Commission on Feb. 8, 1983 when they approved the design of the bridge, after a public hearing, and wrote it "is clearly contemporary yet evocative of the spirit of the church."

"For a project designed to visually alter the face of one of the city's most notable landmarks," reported New York *Newsday*, "there was surprisingly little public outcry. . . . The issue failed to elicit even one objection." The newest of New York's bridges does indeed look like it has always been there.

Design Concept a Challenge

The 86-ft long, 8-ft-wide pedestrian bridge also represents a significant engineering challenge. One problem was that the bridge could not be supported simply by the building and the church. In addition, a 16-ft high, 100-yr. old gravity retaining wall surrounding the church could not withstand the loads of the new structure either. Therefore, to make construction of the bridge possible, it was designed as an overhanging beam to cantilever to the retaining wall from an intermediate support at the curb line. The 19 ft-4-in.N cantilever was not supported on the retaining wall under dead load. This cantilever action under dead load greatly reduced the load on the parish headquarters building so that no reinforcement in the columns or building foundation was required, although a new spandrel girder was added to transfer loads to the building. Otherwise, the reinforcement would have been very costly, if not impossible. The cantilever was supported and anchored at the retaining wall for live load to increase stiffness and reduce the live-load deflection, making the induced transient vibration due to pedestrian traffic acceptable.

The intermediate support consists of two 15-in. dia. circular ASTM A572 steel columns supported by a pile cap which, in turn, rests on two off-center, 12-in. dia. steel pipe, concrete-filled piles. Because of a multitude of subsurface obstacles, including utilities, the exiting sewer and the subway, approval from various New York City agencies was required before the piles could be driven. To satisfy clearance requirements, there was room for only two piles which had to be squeezed within a 7-ft horizontal space between the subway and sewer (each requiring a 3-ft clearance from the piles) and drilled straight through an abandoned elevated subway structure. All piles were augered in with steel casings until beyond the subway foundation. When driving the piles, the subway structure as well as the church retaining wall were monitored for harmful vibrations with velocity meters. The information obtained from the test pits and borings in the foundation area was given to prospective bidders prior to the award of the construction

Closeup of bridge shows intricate detailing of structural steel and railing.

Trinity Bridge transported to busy Manhattan street in one piece on special trailer.

contract. This avoided any construction cost extra or time delay.

Another problem was the fact the parish house was not aligned directly with the church portico. Therefore, the bridge was designed with a small skew and a 37-in. drop from the parish house to the church to provide smooth crossings. A maximum grade of 5% allows wheelchair access. To obtain vertical clearance, the bridge profile was broken by a graceful 34-ft vertical curve which maintained the required highway clearance and arch configuration at the intermediate support.

An important consideration in developing the design concept was that, because of the busy traffic on the narrow streets of lower Manhattan, the construction of the bridge could not interrupt the normally heavy vehicular and pedestrian traffic on Trinity Place. To solve this problem, the bridge was conceived, designed and detailed as a steel bridge, shop-welded and fabricated in one piece and erected as a unit.

Structural Details

The bridge is a pair of Vierendeel trussed deck arches spaced 7 ft apart and tied together by 6-in × 1½-in. rectangular tubes at the bottom and #18-ga. steel deck form at the top. The deck form not only supports the 4-in. concrete deck with its granite paving, but also served as a horizontal shield for street traffic protection during construction.

All the steel in the bridge is A572 Gr. 50. The top and bottom chords of each arch are welded "T" sections. In the Vierendeel sections adjacent to the supports, the vertical members connecting the two chords consist of one web plate lined up and welded to the webs of the top and bottom chords and two "T" sections, cut from rolled, wide-flange "I" beams. Elsewhere, top and bottom chords merge to form a single "I" section by using a common web plate with a total depth of only 16½ in. in the mid-portion and 8½ in. at the east end respectively. These shallow depths not only create a graceful appearance but also provide ample vertical clearance. The complete structure was analyzed and optimized as a three-dimensional structure by using a computer for the most economical construction. The effects of a future enclosure for the pedestrian bridge, especially the wind load on the enclosure, were also considered.

All the welds on the bridge are fillet welds, with the exception of the welds at the splice plates, deck form supporting shelf plates and connections to the columns, which are full-penetration butt welds.

Fabrication

The greatest concern in the fabrication of the bridge was the distortion and/or warping of the completed structure caused by shrinkage caused by welding, since the overall visual appearance of the complet-

Bridge swings into place overnight to eliminate any traffic jams.

ed bridge at the site is of prime importance. The distortion was controlled by using symmetrical, built-up sections, with a minimum amount of welding and very strict tolerances as specified in the fabrication contract. Since each of the two arches was to be fabricated in the flat position, i.e., the structure lying on its side, the engineer furnished a camber diagram. The vertical alignment, as well as the deflections of the structure due to present and future dead loads when the structure is in an upright position, were taken into account. By giving the camber diagram and tolerances, the engineer took the responsibility for geometry, which resulted in a lower bid price. The fabricator met the fabrication tolerance by using proper welding techniques and carefully planned welding sequences with the approval of the engineer. He also chose to cut the webs of the chords and the vertical members of each arch near the column supports from one single plate and the flanges of the bottom chords from a single curved plate. In so doing, the welding of many small pieces was eliminated to avoid the consequent shrinkage and distortion associated with welding. For quality control, all butt welds were ultrasonically tested and 50% of the fillet welds were magnetic-particle tested at locations designated by the engineer, including interpasses.

(continued)

Closeup of single-web plate welded in fabricator's shop and pre-assembled into complete bridge.

Erection

The complete shop-welded structure was shipped from Avonmore, Pa. to the job site in one piece in an upright position by using a specially designed trailer. It was driven across the George Washington Bridge and moved down Broadway in Manhattan late at night on Nov. 7, 1987 under police escort.

On Sunday, Nov. 8, 1987, the Trinity Church Pedestrian Bridge was erected in just 90 minutes. Bolted to the flange plates of the two previously erected steel columns with eighteen bolts each, to the building with eight bolts, and to the church retaining wall with four bolts, the operation was smooth and fast. Careful planning, meticulous engineering, precise fabricating, skilful erection, quality control and coordination enabled the total of forty-eight bolts to the four independent supporting structures to fit with a tolerance of $\frac{1}{16}$ in.

Railing and Deck

The ornamental railing, installed after the bridge was erected, is shaped like a row of X's and is highlighted by a bronze medallion at the center of each X, just like on the century-old Loew Bridge. With the exception of some other bronze ornamental items, such as the ball finial at the top of each post and the upper and lower horizontal half-round mouldings, the railing is *entirely made of A36 steel tubings, bars,* channels and plates. All the elements were shop-welded and pre-assembled in the shop before installation—which showed that the beautiful cast-iron work of old can be recreated in today's steel welding shops. Bronze footlamps and granite paving covering the cast-in-place concrete deck provided finishing touches in keeping with the historic setting.

Maintenance Considerations

For minimum maintenance, drain holes are provided at all low points of the bridge to avoid the collection of water. Snow melting conduits were embedded in the concrete deck with an electronic sensor system that will automatically melt ice and snow, and the drainage system discharges all the water into an existing drain to prevent it from running back into the church from the bridge. All the drain pipes are provided with heat tracer cables to prevent the water from freezing. Furthermore, an epoxy based paint with sandblast cleaning was specified and used to assure long life.

New Vista for Old Landmark

The Trinity Church Pedestrian Bridge provides a safe, convenient link between the church and their parish house across Trinity Place. Because of careful planning and the consideration of fabrication and erection, as well as preventive measures to avoid any extra construction cost in the preparation of the construction contract documents, resulted in a very economical structure. To minimize traffic disruption during its construction, the use of welded steel construction made it possible to fabricate the bridge in one piece and erect it as one unit.

The aesthetic aspect of the bridge design was of prime importance because of its location. Again, the use of welded steel construction made it possible to produce an elegant, Vierendeel-trussed arch with thin members, almost transparent in appearance. From the first moment, the bridge looked so appropriate in its setting, and the disruption to the area had been so minimal, that many New Yorkers hurrying to work the next morning were not quite sure if the bridge had not always been there. Those who noticed, however, agreed that the bridge actually enhances the setting and creates a whole new vista for the beloved landmark. □

Architect
Lee Harris Pomeroy Associates
New York, New York

Structural Engineer
Ammann & Whitney
New York, New York

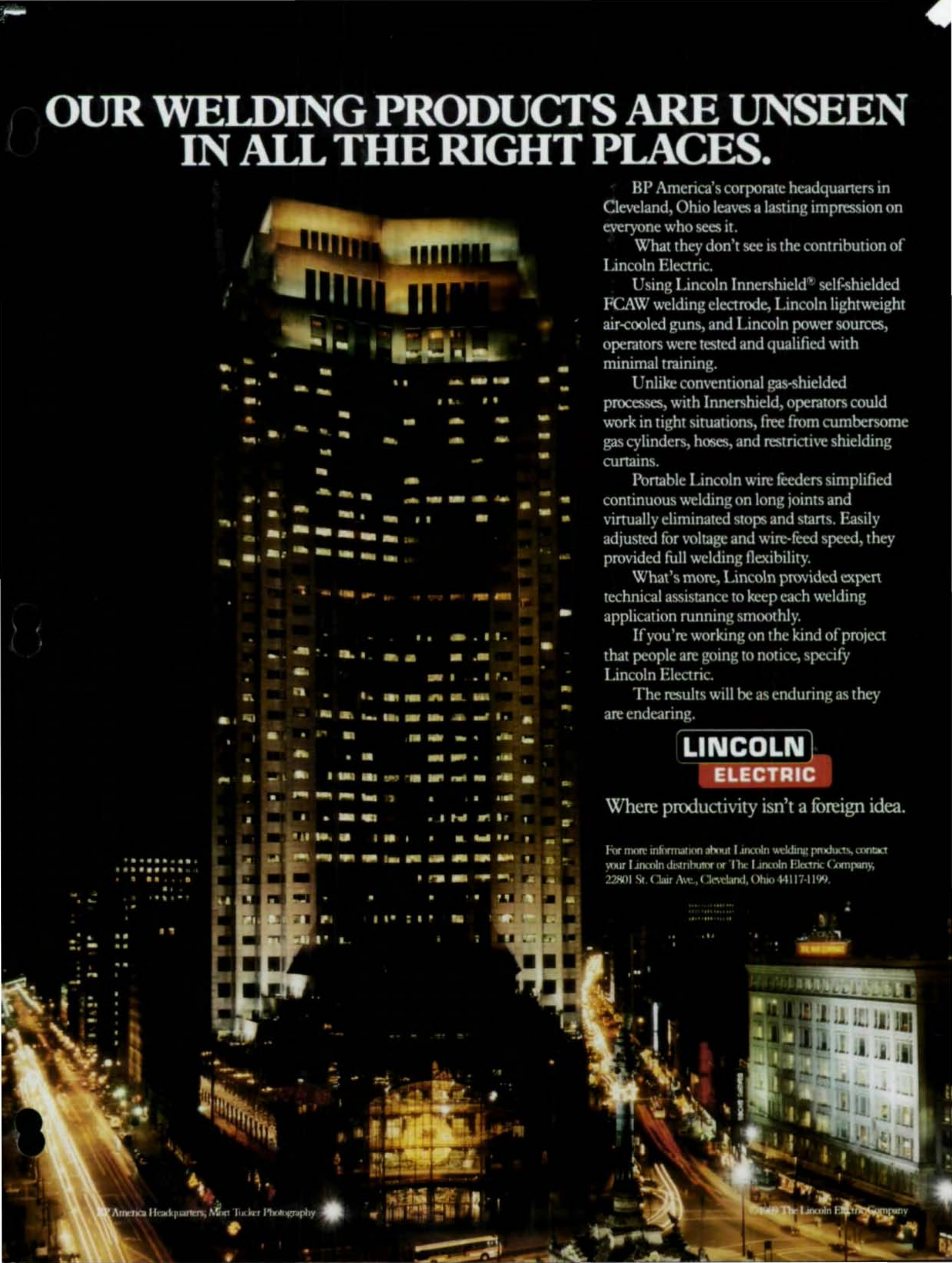
General Contractor/Steel Erector
Nab Construction Corporation
College Point, New York

Steel Fabricator
Reynolds Manufacturing Co.
Avonmore, Pennsylvania

Owner
Parish of Trinity Church
New York, New York

Edward Cohen is managing partner of the structural engineereing firm of Ammann & Whitney, New York, New York.

Trinity Church Pedestrian Bridge was recently selected as the winner in the 1989 AISC Prize Bridge competition—Special Purpose category.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d Nuts, They Have To Earn Their Stripes.

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Bracing Enters Computer Age

Photo courtesy Structural Software Co.

Braces are usually stamped with identifying numbers, so erectors spend most of their time finding them and moving them from one spot to another. The various braces that stiffen modern steel construction are not interchangeable. Whether they are called diaphragms, wind braces, X-braces, V-braces, K-braces, knee bracing, symmetrical or nonsymmetrical, each brace is as unique as the horizontal or vertical position where it is bolted or welded. A one-at-a-time, hand-crafted item.

Braces can be made of angles, beams, pipe, tube, flat bars, rods and tees. Tees can be bolted through the web, or through the flange. On a long bridge, otherwise identical diaphragms (X-braces that separate parallel plate girders) come with and without holes. They are bolted into position on the straight stretches of bridge and welded into place on the curves where the clearance is lacking to use a pneumatic wrench.

Detailing braces requires algebra, geometry, trigonometry—and hours—each and every time. Every brace has a unique solution, one that probably will not work for the next brace on the job. One overlooked obstruction or critical dimension and all the previous work can be useless.

The bane of the detailer's life, however, is the change order. Alter an elevation, or widen a bay, and a cascade effect ripples through all the other dimensions, rendering every connected brace obsolete.

The American civil engineering profession imposes additional hardships. The metric world works in base 10. In the U.S., work is calculated in base 12 (in. per ft).

(continued on p. 46)

When The Bridge Was Out, We Came Across.

It was the worst flooding upstate New York had seen in thirty years.

As the swollen waters of the Schoharie Creek raged out of control, the four-lane bridge above it gave way. So, the New York State Thruway Authority faced some tough problems. They simply couldn't afford a prolonged bridge closure at this vital link of Interstate 90.

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GERALD R. FORD AMPHITHEATER

Commanding Views of the Rockies

by Richard Weingardt

The citizens of Vail envisioned an amphitheater as the centerpiece of their 23-acre Gerald R. Ford Park which adjoins City Center. The community project, 10 years in the making, began with several false starts and a scheme which was too costly. As originally conceived, it was a large, bulky and overwhelming structure with interior roof columns which interfered with a view of the stage. A concrete stage along with some outdoor seating was actually constructed before changing direction and hiring a new architect for a revised concept.

The new design using exposed structural steel frames reduced the cost from $5 million to $1.75 million and gave the citizens of Vail a light, airy structure in harmony with the mountains.

Columns Eliminated Using Steel

After the architects, Morter-Fisher, were hired to redesign with a new concept, they retained Richard Weingardt Consultants, Inc. as their structural engineers, whose structural design eliminated interior columns.

Engineers had to design the theater structure around the stage and seats already constructed from the previous design. The theater, which is 17,000 sq. ft, provides 927 fixed seats and informal outdoor seating for 2,500. The fixed seats wrap around the modified thrust stage to provide the intimate audience/performer relationship appropriate for such a facility. In addition to the theater structure, the facilities include: a ticket sales area; a concessions area; restrooms; a green room and dressing rooms; a storage and receiving building; and a full basement below the stage. The stage is designed to accommodate an orchestra pit in the future. A large plaza near the entry, seating and concession areas accommodate large

Amphitheater is central element of 23-acre Ford Park. Natural land bench shaped site. Exposed steel structure is the architecture. Free-standing space trusses are structurally sound without need for lateral resistance of roof decks (l. and above).

groups during intermissions and special events.

Built In Stages

Since no public funds were available, the theater was built in stages as money was raised by private citizens. The structure was designed so each phase of construction was structurally adequate by itself. No tax dollars were used. Fund-raising, as well as construction, took three seasons. The community spirit during the fund-raising efforts caused former President Gerald Ford to remark, "I am very happy to see the current effort by so many people to move the Ford Amphitheater to completion. It's a facility which will add to Vail's reputation as a complete year-round resort."

Structure is architecture at amphitheater, where space is defined by tubular steel trusses that are light and sculptured and lend feeling of spaciousness.

Public Design Sessions

Prior to preparing the drawings, public design discussions were held. During these sessions, individuals from all areas of the community were asked to provide input to the design team so their specific concerns could be addressed. Included were the town council, police and fire officials, private individuals and prospective users of the facility. The proposed facility was modified continuously during design to best accommodate the issues raised.

Traditionally, outdoor concerts in Vail, Colo. had been informal affairs: bring a blanket, a picnic basket and let the kids run on the nearby slopes, while the entertainers performed under a makeshift tent. The new amphitheater continues that tradition of informality. More than half of the seats are on grass berms. The backdrop for the stage is a stand of 100-ft high spruce trees along Gore Creek. Beyond, the Rocky Mountains wrap around the facility on the remaining three sides.

At these public design sessions, many residents also stressed the importance for good acoustics and the need for a real feeling of quality. The citizens wanted a notable facility with a light and airy feeling—a feeling of spaciousness. They did not want a structure which was "just one big roof."

Acoustical Roof Panels "Float"

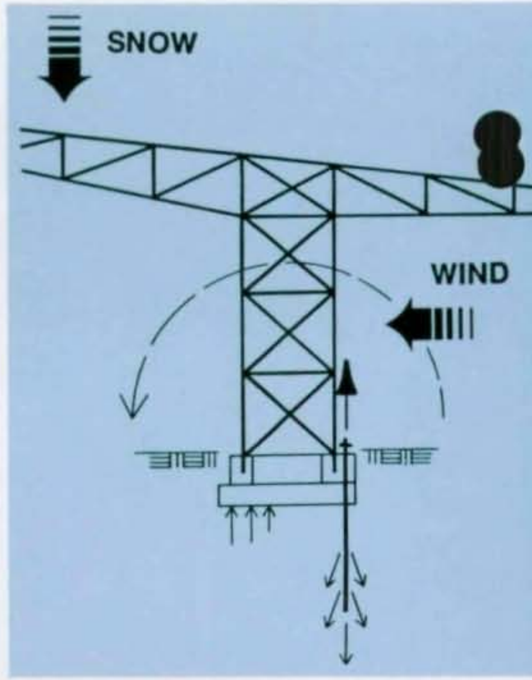
The seven roof panels, arranged for the best acoustics, were designed to "float" above the performance area. Tubular steel space frames support these roof panels, yet do not obstruct views of the stage, even from the outdoor seating areas. The structural steel truss system consists of both long cantilever frames and 100-ft wide arch frames. They were used not only because of economics, but also because they lend the feeling of spaciousness the citizens of Vail desired.

The steel frames withstand heavy wind and snow loads, while offering the visibility and aesthetics desired. The frames are true space frames in that they, by themselves, are capable of resisting lateral as well as vertical forces, without reliance on a roof diaphragm or walls. The roof was designed to support loads of 84 psf; laterally, the frames will resist 90-mph wind forces.

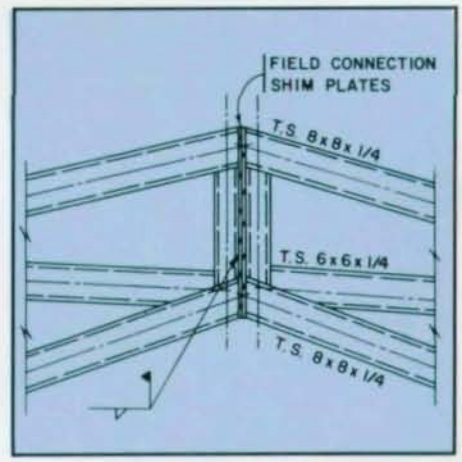
The complicated three-dimensional steel frames were shop-fabricated in large sections and field-assembled. Connections were carefully detailed so as not to detract from the beauty of the steel structure since it is exposed and serves as architecture. Frame segments were designed to allow erection without using heavy equipment. Field connections were kept clean and simple. Their geometry was quite complex because the frames intersect at various planes, which were dictated by acoustical requirements.

Structural Systems Detailed

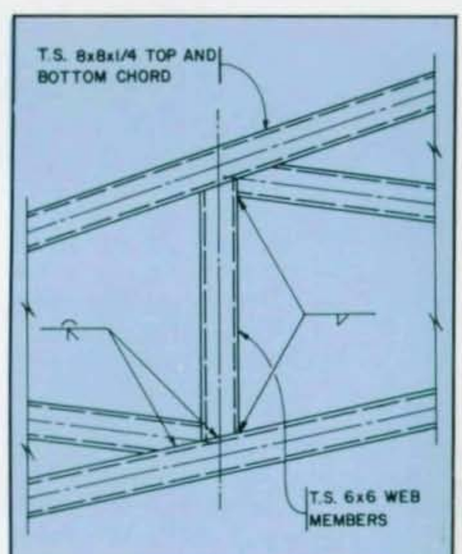
The structural system for the amphitheater itself consists of steel tube space frames, either cantilevered or gable bents. Main



Unconventional soil tension anchor system was engineered composite with spread footings—simple and safe in resisting large forces.



Frame peak connection (above). Typical frame detail below.



frame members are $8 \times 8 \times \frac{1}{4}$ while secondary members are $6 \times 6 \times \frac{1}{4}$. Both tube sizes are ASTM A500 steel. The tube pieces were welded either in the shop or field. Spanning between the frames are long-span, open-web roof joists. The joists, which vary from 36 LH 14's to 18 LH 04's and spaced at 8 ft o.c., support the wood roof deck. The deck, made up of 3×6 tongue-and-groove wood planks, is bolted to the steel joists.

The roof structures over all other enclosed spaces of the complex are constructed of standard lightweight steel members. Typical roof joists are 24 H6 at three ft o.c. on masonry bearing walls, with one in. deep metal deck. Except for the stage, all floors are slab-on-grade construction. The full basement under the amphitheater stage is framed over with 24 in. deep (ASTM A36) steel girders. The $W24 \times 68$ girders are spaced at 8 ft o.c. and support a $6\frac{1}{2}$-in. concrete topping and 2-in. metal deck stage floor system. A total of 127 tons of structural steel went into the Ford project.

Two hexagon tube-plate connections at intersection of several truss frames.

Unique Rock Anchor Footings

Because the soils contained large cobbles and rocks, standard drilled pier footings could not be used and regular spread footings would not resist the large overturning forces of the long, cantilevered roof-truss frames. An unconventional soil tension anchor system (similar to rock-anchoring used for tunnels) was engineered to act composite with standard concrete pad footings.

The one and one-quarter inch dia. rock anchors were 140,000 psi high-strength steel tie-rods, drilled 18 ft deep and pressure-grouted. They provided the tension resistance necessary to stabilize the large uplift forces of the cantilevered truss frames. This unique application of proven design techniques, though new for large Colorado structures, was simple, safe and economical.

The Dream . . . a Realization

The sweeping overhead V-framing of the steel entrance canopy welcomes attendees to all activities. The first performance, which featured the 60-piece Colorado Springs Symphony, was hosted by Betty Ford. In a recent interview, Gerald Ford commented, "For many years, Vail could not compare with its neighbor and main rival, Aspen, in the area of culture. But now that we've built this outdoor Amphitheater, we can bring in top performers." Vail currently averages three cultural events per week during the summer at the theater, many by nationally recognized performers.

Community Spirit Project

The project brought the whole town together with a common goal and community spirit, while saving $3.25 million. Every penny spent to construct the facility was from citizen donations. Upon the facility's recognition in 1989 by the Consulting Engineers Council of Colorado for "Engineering Excellence," architect James R. Morter remarked, "The Gerald R. Ford Amphitheater is indeed a unique, one-of-a-kind structure. It demanded a unique engineering solution and a unique range of engineering services. Of even greater importance is the satisfaction and acceptance of the performers and audiences who have enjoyed using the facility." □

Architect
Morter Fisher Architects
Vail, Colorado

Structural Engineer
Richard Weingardt Consultants, Inc.
Denver, Colorado

General Contractor
Duddy-Viele Contractors
Vail, Colorado

Owner
Vail Valley Foundation
Vail, Colorado

Richard Weingardt, P.E., is president of Richard Weingardt Consultants, Inc., Structural Engineers based in Denver, Colorado.

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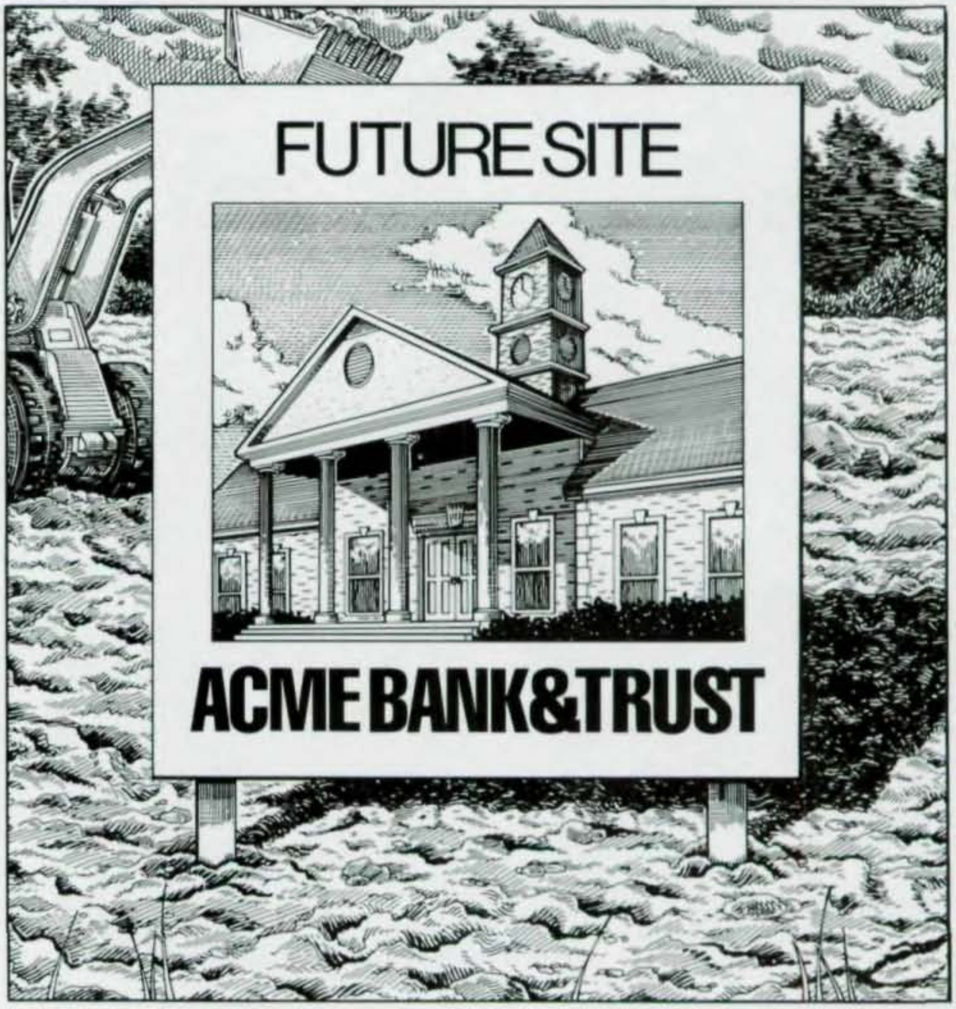

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What Structural Engineers and Fabricators Need to Know About Weld Metal (Part I)

by Duane K. Miller

To supply structural engineers and fabricators with the mechanical properties data needed to ensure good weldment design, manufacturers of consumables use standard filler metal qualification tests developed by the American Welding Society. Tensile properties are thus reported. Too frequently, engineers expect the results of these tightly controlled tests to be applicable directly to the properties of welded connections made in the shop or in the field. They are not. Both the structural engineer and the fabricator need to be aware of the ways in which many variables may affect the properties of the weld deposit.

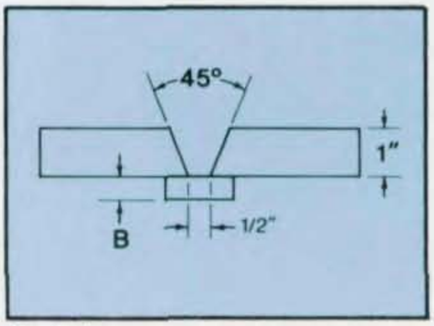


Figure 1

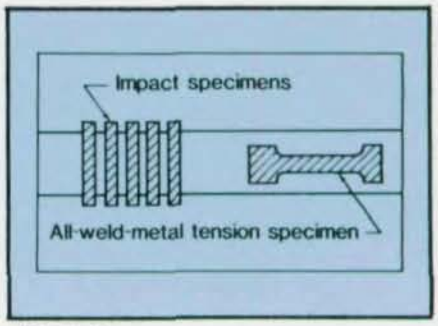


Figure 2

Designing Welds

When a structural engineer is designing a welded connection, that weld typically will be a fillet weld, a full-penetration butt weld, or a partial-penetration weld. It is being designed for a particular strength requirement. The fillet weld strength will be proportional to the leg size, the length and the strength of the filler metal. A butt weld will be proportional to the cross-sectional area and the strength of the filler metal. A partial-penetration weld will have a strength proportional to the depth of penetration, the length and the strength of the filler metal used. So, in any of these three situations, the strength of the filler metal used is critical to the performance of the particular joint.

Properties Required

The word "strength" is used here specifically, because in some cases yield strength is more important, and sometimes tensile strength is more important. Most welded connections are designed around the tensile strength, but the yield strength is very often the controlling factor since permanent deformation is not desirable. The modulus of elasticity, used for designing structure stiffness, is not a structure-sensitive property and therefore is not within the scope of this discussion.

Another strength factor that does not figure into the strength equations mentioned above is toughness, a very difficult property to use in design. Fracture mechanics is required to utilize the property of toughness. However, impact resistance measured by the Charpy specimen is frequently used. To that extent, this paper discusses the effects of variables on toughness. Toughness properties are not required by AWS D1.1 structural code, however, unless specified in contract documents.

The structural engineer requiring the properties of yield strength and tensile strength may go immediately to the electrode classification to try to discern these. Using an example of a typical low-hydrogen electrode, an E7018, he may look at the 70 designation, knowing that 70 stands for a minimum tensile strength of 70,000 psi, and use that for design purposes. The same strength level may not be seen in the actual weld joint selected by the engineer. To understand why, it is necessary first to review filler metal specifications and qualification tests.

Filler Metal Specifications

Mechanical properties requirements spelled out in the AWS classification include specific yield, tensile strength and elongation properties. Charpy values for toughness may or may not be specified. Certain chemical properties are specified, indicating key alloy levels. Finally, there may be welding performance criteria such as the percentage of moisture in the coatings of low-hydrogen electrodes. A look at a typical certification demonstrates that electrodes exceed the minimums specified. However, note that the Appendix to the filler metal specification includes restrictions on the use of this information, as follows:

> "Weld metal properties may vary widely, according to size of the electrode and amperage used, size of the beads in the weld, plate thickness, joint geometry, preheat and interpass temperatures, surface condition, base metal composition, dilution, etc."[1]

The test plate was never designed to duplicate the actual welding properties. It would be impossible to duplicate all of the properties that may be encountered. The purpose is for *classification* or *qualification* of a particular product to a *specific filler metal type*. It does permit comparisons *within* the specification. That is, one E7018 electrode can be compared to another. But technically, an E7018 electrode cannot be compared to a deposit of submerged arc, for example, because there are differences between the tests.

Test Controls

In relying on test results, the engineer again will do well to heed the Appendix to the filler metal specification:

> "Properties of production welds may vary accordingly, depending on the particular welding conditions. Weld metal properties may not duplicate, or even closely approach, the values listed and prescribed for test welds."[2]

These tests were actually designed to *minimize* variations in results due to testing from one manufacturer to another, from

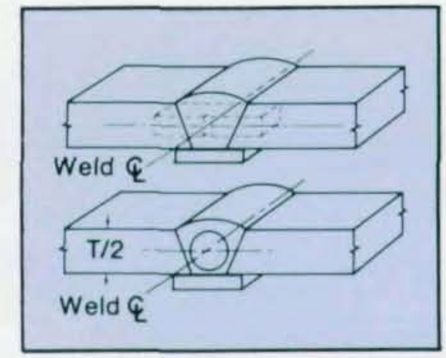


Figure 3

one year to another and from one product to another.

An in-depth look at one test, for a low-hydrogen stick electrode, will help to clarify the purpose of the tests. That product, a shielded metal arc-welding electrode, is covered in AWS A5.1. The mechanical properties are those with which structural engineers are most concerned. The first step is to find out what tests are required by the specification. Table #8 in that spec indicates that for an E7018 electrode, 3/32-in. dia. and 1/8-in. dia. electrodes do not require mechanical testing. For the 5/32-in. dia. electrode, however, an all-weld-metal tension test is required, with the plate to be welded in the flat position. Out of the same plate, impact specimens are to be taken and also a fillet weld test is to be performed in the vertical and overhead position to ensure weld soundness.

The 3/16-in. dia. electrode has the same requirements for mechanical testing as does the 5/32-in. dia. However, the fillet weld is to be made in the horizontal position, as opposed to the vertical and overhead position of the 5/32-in. A 7/32-in. dia. electrode does not require any mechanical tests.

The 5/32-in. electrode can be subjected to a closer look, since it does require mechanical testing. The next step is that the particular test plate to be used must be made of one of the three grades of steel listed: A285 Gr. C; A36; or A283 Gr. D. Typically, A36 is used. The plate is to be configured per Fig. 1. That is, a 45° included angle, with a 1/2-in. root opening, a plate thickness dependent on the electrode size, typically a 3/4-in. or 5/32-in. electrode *and a backing bar appropriate to the size* of electrode being used. The plate is to be pre-heated to 225° F., plus or minus 25°. Interpass temperature is to be maintained at 225° to 350° F. The amperage is suggested to be run between 150 and 220 amps. The welding sequence is specified. The first layer is to be made with a full weave, with one layer for the entire half-inch of the root opening. The second and all subsequent layers are to be welded

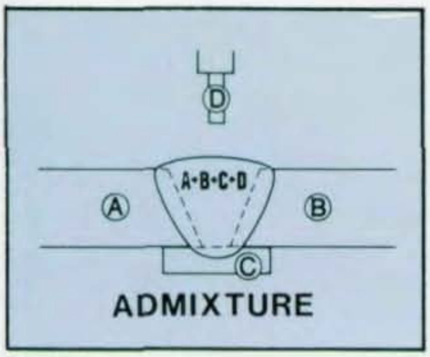


Figure 4

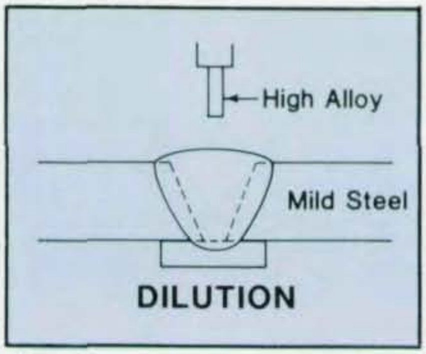


Figure 5

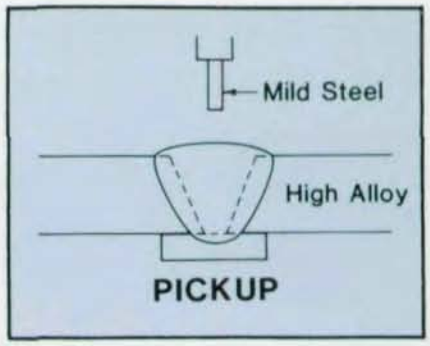


Figure 6

with two passes per layer. A total of seven to nine layers could be used to make this weld specimen. Dictating the amperage and welding sequence restricts the travel speed. Note that the test plate will always be multiple pass, with a minimum of 13 relatively small beads.

The specimen is to be tested per ASTM specifications. The test specimens are to be removed from the plate configuration, as shown in Figs. 1, 2 and 3. The machining of the test plate, the accuracy of the test instruments, etc., are all covered in the ASTM specifications. For the E7018 electrode, the all-weld-metal tensile strength must be a minimum of 72,000 psi. Yield must be 60,000 psi minimum. Elongation must be 22% minimum. The impact energy must be a minimum of 20 ft-lbs. at minus 20° F. In addition, there are chemical and performance tests that are not discussed here, but if all these other criteria are met, it may be classified as an E7018 SMAW stick electrode.

Other consumables may be tested in a different form. For instance, consider the E6010 electrode, which is still within the A5.1 specification. In this case, the specimen can be aged at 200° to 220° F. for 48 hours, plus or minus two hours. This permits any hydrogen to escape from the weld metal; This test is not designed to hide the fact that hydrogen may be present in the weld metal; its purpose is rather to present a very consistent way of comparing products that may have hydrogen in the weld metal. If, for example, the weld specimens are not tested for two to four weeks after welding, most of the hydrogen has escaped from the sample. This is an accelerated way of letting the hydrogen escape to ensure the consistency of test results.

A different filler metal specification, A5.20, for flux-cored arc welding, shows that the ambient or starting temperature for the test plate is room temperature, vs. the low hydrogen test under 5.1, which called for an initial temperature of 225° F. Here, the initial temperature is specified as 70° F. In addition, flux-cored arc welding may utilize externally supplied shielding gas. When required, the controlling gas is to be carbon dioxide.

A consideration of specification 5.17 for submerged arc welding demonstrates the procedure is tightly controlled for testing. The 5/32-in. dia. electrode should be used at 550 amps and 28 volts. There can also be post-weld heat treatment, or stress relieving, of submerged arc welds and other products as well. The stress relief temperature is 1,150° F., plus or minus 25°, and the weld should be stress-relieved for one hour.

Effects of Deviations

These test configurations and controls may or may not represent the actual welding conditions. Indeed, in the majority of situations, there will be deviations. Such deviations as amperage, weld bead placement, plate thickness and so forth, have already been noted. These can be classified, however, into two broad categories: chemical and thermal changes.

Chemical Effects

Chemical changes are due to two key influences: first, the plate chemistry and secondly, the amount of admixture. Three

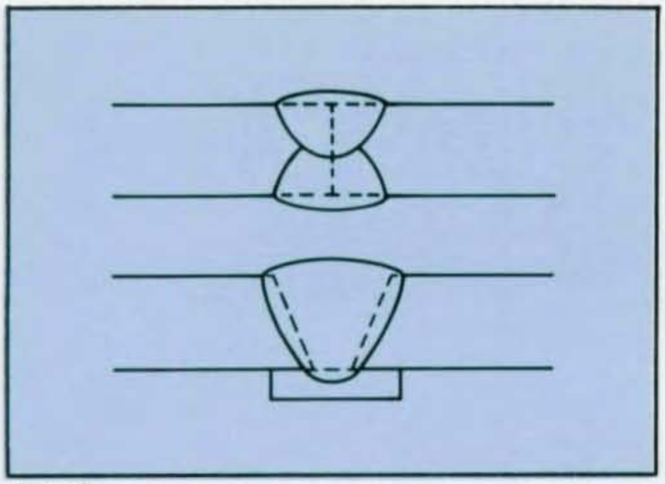


Figure 7

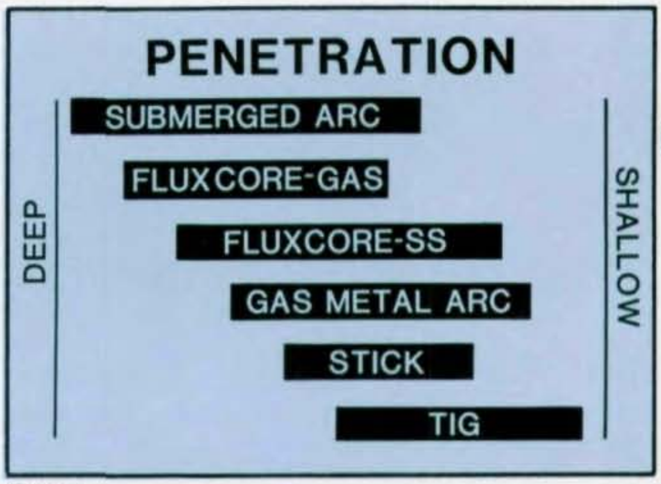


Figure 8

terms may need definition here: admixture, dilution and pickup.

Figure 4 helps to illustrate admixture. As the illustration shows, this weld is joining plate A to plate B. A backing strip labeled C is included. The joint is to be filled with a filler metal labeled D. The arc force and energy of the electrode will melt some of plate A, some of plate B and some of plate C. The final composition of the weld metal will be A, B, C and D. This conglomeration of material is called "admixture."

Figure 5 illustrates dilution. Dilution occurs when a high alloy electrode is used to weld on lower alloy plate. Thus, as the high allow is mixed with the lower alloy, creating an admixture, the high alloy is diluted. For example, using a stainless steel electrode with high chrome and high nickel to weld on mild steel, will result in lower chrome and nickel content in the weld than in the electrode. This result is called "dilution."

Figure 6 shows alloy pickup, which is just the opposite of dilution. Here, a mild steel electrode is used to weld on high alloy plate. The weld deposit will contain nickel that was never present in the mild steel filler. When the deposit contains a greater amount of alloy than the electrode, the situation is referred to as alloy "pickup."

As base plate is introduced into the admixture, the weld chemistry changes. If the plate chemistry is different than that used for filler metal qualification, the weld chemistry may be different. The significance of this will be considered later.

The extent of admixture is a function of joint geometry, the process used and procedures. Since few people weld AWS filler metal qualification plates in production, the test plate is not typical of most production joints.

Figure 7 shows two different butt joints. The plate thickness is the same in both cases. One involves a penetration weld, welding from two sides. In this example, the bottom side was welded first, then the plate was turned, the top side was welded and full joint strength was achieved. The artwork shows there would be a tremendous influence of base material in this particular weld, as shown by the dotted lines. A high percentage of the base metal would be contained in the weld metal. This admixture would be composed primarily of base material.

The second butt joint in Fig. 7 shows a beveled joint with a backup that comes close to approaching that of a filler metal specification. Here, minimum amounts of base material are melted. The admixture is composed primarily of the filler metal. So the joint geometry plays an important role in determining the composition of the admixture.

The process selected is very important with respect to penetration. Figure 8 delineates six major arc welding processes; the degree of penetration will vary according to the process. The deepest penetrating process, the one in which the base material has the most significant effect, is submerged-arc welding. At the other extreme, gas tungsten arc welding or TIG welding has relatively shallow penetration, still giving adequate fusion, but the base material has a lesser effect. Between these two extremes are: the flux-cored gas process, which gives relatively deep penetration; the self shielded, flux-cored process, which can have a tremendous range in penetration; the gas metal-arc process, which features deep penetration in the spray mode and relatively shallow penetration in the short arc mode (note: the latter is restricted on structural applications); and the stick electrode process or shielded metal-arc welding, which has a tighter range. For a given process, the extent of penetration is a function of amperage and electrode size. Travel speed, polarity and welding position affect the penetration to a lesser extent (Fig. 8).

References

1. "Specification for Covered Carbon Steel Arc Welding Electrodes," Appendix, p. 25, ANSI/AWS A5.1-81, Oct. 30, 1981
2. Ibid. □

Duane K. Miller is a welding engineer with The Lincoln Electric Company, Cleveland, Ohio.

Bracing Enters *(cont. from p. 30)*

Furthermore, angles are not measured in degrees, radians or grads, but in terms of "bevel," a ratio of twelve to a number less than twelve.

A top-notch detailer can only calculate, draw and dimension a few X-braces per day. Since re-doing a completed job is one of the high-ranking morale destroyers, change orders can reduce that figure even further. In a job requiring thousands of braces, this is a limitation of which the engineer and designer needs to be aware.

As late as the 70's, the primary tool detailers used for designing braces was the venerable *Smoley's Parallel Tables of Slopes and Rises*. First published in 1906, this "detailer's bible" provided the missing numbers for all the slopes, starting at 0 in. to 12 in., all the way to 12 in. to 12 in., at 1/16 in. intervals. Included in the introduction were the equations the detailer could use to solve braces, one member at a time.

Enter Computers

The computer revolution is starting to make its way into the detailer's office. Since even the simplest microcomputer can perform thousands of calculations per second, it is faster to re-invent the wheel, to recalculate each brace dimension from scratch, than it is to look it up in Smoley's. Braces can be calculated instantly with an inexpensive MS-DOS program which will compute the critical dimensions and clearances for symmetrical and non-symmetrical X-braces, knee braces, V-braces and K-braces, in horizontal and vertical orientations. If the brace is bolted, the dimensions needed to locate the bolt holes are also supplied. By automating the algebra, geometry and trigonometry required to solve braces, the detailer can shave hours off the time required to create shop drawings, thus helping the engineer, client and contractor to meet deadlines.

The better programs on the market are congenial to the peculiarities of American civil engineering, and can work in feet, inches and fractions. The computer can also calculate any "bevel" instantly and give the user the numbers needed in familiar form.

Further Efficiency with Programs

Further efficiency can be gained with companion programs which create the drawings—for all of the braces described above—and plot them through a PC CAD (computer-aided design) program. Using this approach, the fabricator can automate the designing and detailing of braces fabricated of angles, beams, pipe, tubes, flat bars, rods and tees (flange or web). As an example of the time savings this makes available to the engineer, the drawings in this article were created by such a program in less than *five minutes* per drawing. This means that a single detailer could do shop drawings for 50 braces a day, instead of two, along with detailed cutting instructions. Overall, the increased speed collapses the scheduling process dramatically at what had been an intractable bottleneck. Financially, the engineer or builder can reduce his risk of penalty clauses and back charges.

There is something to be said for craftsmanship. When one looks at a well-executed, hand-drawn detail, or a well-made log cabin, he can see the pleasure the builder took in his work and his skill. Neville Shute Norway, novelist and engineer, spoke of the near-religious ecstasy he experienced when all of his slide-rule calculations worked out, everything fit and he looked upon perfection.

On the other hand, survival has its charms as well. Survivors make the best use of the best tools available. □

Fabricators & Engineers, Working Together

1990 NATIONAL STEEL CONSTRUCTION CONFERENCE

KANSAS CITY CONVENTION CENTER

KANSAS CITY, MISSOURI

ADVANCE PROGRAM & REGISTRATION FORM

MARCH 14-17, 1990

SPONSORED BY THE

AMERICAN INSTITUTE OF STEEL CONSTRUCTION

HOTEL RESERVATION FORM

MAIL COMPLETED FORM DIRECTLY TO HOTEL SELECTED. RESERVATIONS MUST BE ACCOMPANIED BY ONE NIGHT'S ROOM DEPOSIT: HOTELS ACCEPT DEPOSITS MADE BY CHECK OR BY AMERICAN EXPRESS, VISA, MASTERCARD, DINERS and DISCOVER. NOTE: Amenities will vary; you may wish to call individual hotels for information on complimentary breakfasts, cocktails, etc., which are included in some rates. If reserving rooms by phone, advise hotel you are attending the **AISC National Steel Construction Conference.**

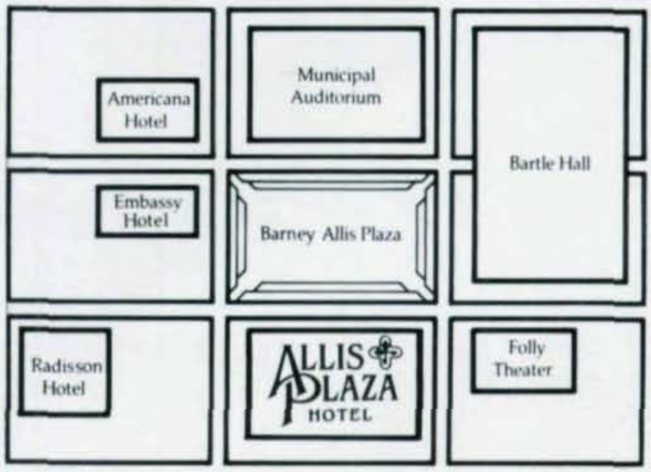
Check (X) Hotel Selected and Circle Room Rate Under Room Type Selected:

Hotel Selection	Single	Double/ Double (2 beds)	Double/ King/Queen	Studio Suite	1-Bdrm. Suite	2-Bdrm. Suite
__**Allis Plaza** 200 W. 12th St. Kansas City, MO 64105 Phone: 816/421-6800	$79	$79	$79	N/A	$260	$335
__**Radisson Suites** 106 W. 12th St. Kansas City, MO 64105 Phone: 816/221-7000	68	80	80	78*	88*	N/A
__**Embassy on the Park** 1214 Wyandotte Kansas City, MO 64105 Pone: 816/471-1333	62	74**	74	N/A	88*	N/A
__**Americana Hotel** 1301 Wynadotte Kansas City, MO 64105 Phone: 816/221-8800	55	65	65	N/A	N/A	N/A

Special Requirements: ______________________________

*Rate quoted is for single occupancy; if additional person in room, add $12. Rates do not include room tax of 9¾%.
**Limited Availability.
N/A: None available.

Hotels will honor and guarantee reservations received by February 12, 1990, so mail this form promptly. Refunds will be made only when cancellations are received at least 24 hours prior to scheduled arrival.



Please reserve the accommodations indicated above for:

Guest Name: ______________________ #Adults ________ #Children ________

OR sharing room (dividing bill) with: ______________________

Organization or company: ______________________

Mailing Address: ______________________

City: ______________________ State: ________ Zip: ________

Phone Office (   ) ______________________ Home (   ) ______________________

Arrival Date: ____________ Approx. Arrival Time: ____________ Departure Date: ____________
(Check-in time at all hotels is 3:00 PM; check-out by noon.)

I enclose check for $ ________ payable to Hotel selected **OR**

Please charge deposit to my Credit Card # ______________________
(Circle card used:) American Express VISA MasterCard Diners Discover Carte Blanche

Expiration Date: ______________________ Signature: ______________________

(For information only, call Lona Babbington at AISC, Phone: 312/670-5432)

Kansas City Site for 1990 "All-steel" Show

The 1990 National Steel Construction Conference, the only "all-steel" conference and trade show produced in the U.S., will be held in Kansas City, Mo., March 14-17. Last year's record attendance in Nashville included more than 1,000 fabricators, erectors, consulting engineers, architects, educators and suppliers.

"Heartland of America"

Located in both the geographic and population center of the nation (more than one-third of the U.S. population resides within 600 miles, and more than 55 million people within a day's drive), Kansas City describes itself as the "Heartland of America." Electric and eclectic, casual yet energetic, the city's character features some of the best characteristics of east and west, north and south—a virtual microcosm of Americana. A sophisticated metropolis, it still retains a small-town friendliness.

The city, which spreads out over gently rolling hills and steep bluffs, is an exemplary model of urban planning. Nearly 140 miles of gracious, tree-lined and fountain-studded boulevards wind through neighborhoods and parks.

The arts thrive in Kansas City. Lyric Opera is in its 29th season, the Kansas City Symphony performs regularly from late fall to spring, and the city's jazz legacy is evident in the city's night life. Both the State Ballet of Missouri and the Westport Ballet delight audiences each season. Touring Broadway musicals and locally produced theatre, including children's and dinner theatre, offer another dimension to live entertainment.

Kansas City's museums house everything from the prehistoric to the future: an archeology museum dating back to 200 B.C.; memorabilia of early pioneer life, regional history and the Civil War; collections of miniatures, horse-drawn vehicles and vintage cars; artifacts of black and Hispanic culture. The Nelson-Atkins Museum of Fine Arts is one of the most comprehensive art museums in the country.

Two religious denominations are headquartered in Kansas City. Nearby, Independence is home to the Harry S Truman Library and Museum; Weston has over 100 pre-Civil War (and lived-in) homes listed on the National Register of Historic Places.

Conference Headquarters

The Kansas City Convention Center in downtown Kansas City, Mo. is headquarters for the 1990 Conference. The Center has the space, convenience and flexibility to rate it as one of the top convention sites in the country. Bartle Hall, which will be utilized for the 1990 National Steel Construction Conference exhibits, has 14 loading docks providing direct access to the unobstructed (column-free) exhibit floor. Utility boxes located on 30-ft centers include lines for electrical, water, gas, air and telephone. A floor load of 300 psf live load enables display of even the heaviest equipment. There is ample covered parking for exhibitors and conference attendees (1-day parking only $4). There is also underground access to the Allis Plaza Hotel (conference headquarters hotel), as well as to two of the supplemental hotels: Embassy on the Park and Radisson Suites. A fourth hotel, the Americana, is just one-half block away.

Kansas City International Airport, less than 15 miles northwest of downtown, is served by all major airlines.

Seminars and Technical Program

The 1990 National Steel Construction Conference combines, for the fourth consecutive year, the AISC National Engineering Conference and AISC Conference of Operating Personnel. Special sessions focus on the specific interests of structural steel fabricators, consulting engineers, architects, owners, public officials, erectors, detailers, researchers and educators.

The Conference continues to be the premier meeting place for engineering professionals, the best place to obtain the most information about buildings and bridges designed and built in steel.

Workshop sessions get down to basics, the nuts-and-bolts details of designing, fabricating and erecting structural steel. Every aspect of the construction process from concept to competition receives attention: computerized design, Load and Resistance Factor Design, Autostress Design, project management, shop and field inspection and safety, quality certification, productivity, welding, bolting, cleaning, painting.

The focus is on practical solutions to common problems, and it has also been the first forum for introducing the latest research on structural steel design, recent code changes and technological advances.

Exhibit Booth Space Available

The National Steel Construction Conference offers an ideal marketplace to those who provide products and services to the structural steel industry. In addition to display booths, exhibitors at the 1990 National Steel Construction Conference will also be given an opportunity to conduct a Product/Service Workshop. Introduced for the first time last year, these special sessions offer a forum where companies can share the latest technological advances in specialized fields, conduct demonstrations or question-and-answer dialogues, introduce new or updated equipment and programs. These workshops will be conducted during specific time periods, not in conflict with regular conference sessions, and the schedule will be included as part of the Official Conference Program. Information on exhibit space at the conference is now available from AISC headquarters (312-670-2400).

Pre-Conference Events

This year's Schedule of Events will include an Educator Meeting, concentrating on subjects of interest to those who teach structural steel design courses at colleges and universities; and a Professional Member Forum for structural engineers interested in current programs and publications available from AISC. Other organizations or associations who would like to schedule pre-conference activities to take advantage of this expected high concentration of industry representatives should contact Lona Babbington, Conference Coordinator, at 312-670-5432.

Spouses' Program/Optional Events

In addition to the technical program, the conference will also include a special program for spouses and guests of those registering to attend. A schedule of planned evening and post-conference activities will also be offered.

MSC to Publish Special Show Issue

Modern Steel Construction will publish its January/February issue as The 1990 National Steel Construction Conference Official Program issue. It will also expand circulation for the November/December issue to offer information (including Official Program and Registration Form) to the widest possible audience.

The Pattis Group-3M, Lincolnwood, Ill. is MSC's advertising representative. Eric Neiman (708 / 679-1100) will be happy to give you full details on advertising in this special issue. □

PRELIMINARY SCHEDULE OF EVENTS

MONDAY and TUESDAY — MARCH 12-13

Exhibitor Move-in **and** Pre-conference Events

6:30-7:30 PM **AISC Welcome Cocktail Party**
All conference attendees, and spouses, are invited to attend the Cocktail Party in Bartle Hall, where exhibits will be open until 8:00 PM.

WEDNESDAY — MARCH 14

8:00-12:00 AM **Partners in Education Meeting**
A meeting of AISC's 30-member Educator Advisory Council, which provides data and suggestions for development of programs which will assist those who provide college and university instruction in structural steel design.

8:00-5:00 PM **Committee Meetings**
Organizations or associations who would like to schedule committee meetings or other pre-conference activities to take advantage of this expected high concentration of industry representatives may contact Lona Babbington, Conference Coordinator, at 312/670-5432.

9:30-12:00 AM **Optional Event #1: Tour of Kansas City**
A bus tour of the "Heartland of America" will include Hallmark's Crown Center and the elegant Country Club Plaza, Liberty Memorial, Penn Valley Park, the affluent Mission Hills estate area, and Old Westport (once the largest outfitting post for wagon trains headed west).

Noon-1:00 PM **Partners in Education Luncheon**

1:30-5:00 PM **Educator Session**
Session concentrating on subjects of interest to those who teach structural steel design courses at colleges and universities.

1:30-5:00 PM **Professional Member Forum**
Session for structural engineers interested in current programs and publications available from AISC.

1:30-3:00 PM **General Session: "Construction Claims"**
Moderator: Robert B. Nelson, AFCO Steel, Little Rock, AR
Speaker: David B. Ratterman, Goldberg & Simpson P.S.C., Louisville, KY (and AISC general counsel)
A comprehensive lesson in the fundamentals of avoiding claims, as well as negotiation, arbitration and litigation processes that may be necessary to resolve disputes.

3:00-5:00 PM **Exhibits Open**
No technical seminars are scheduled for this time period, giving attendees an opportunity to visit the 100-plus exhibit booths in Bartle Hall.

5:15-6:00 PM **Exhibitor Workshops**
These special sessions offer a forum where companies share the latest technological advances in their specialized fields, conduct demonstrations or question-and-answer dialogues, and introduce new or updated equipment and programs.
Session A - TradeARBED introduces HISTAR, a new generation of rolled beams and column shapes for economical steel construction.
Session B - Welded Tube Company of America "Structural Tubing for Fabrication"
Sessions C - G also scheduled for this time period; names of additional companies presenting workshops to be announced.

THURSDAY — MARCH 15 (Morning)

7:00-8:00 AM **SASF Educator Breakfast**
Members of the Southern Association of Steel Fabricators will host a breakfast for educators from the states represented in SASF membership.

7:00-8:00 AM **VCSSF Educator Breakfast**
Members of the Virginia-Carolinas Structural Steel Fabricators Association will host a breakfast for educators from the states represented in VCSSF membership.

7:00-8:15 AM **Exhibitor Workshops**
Already scheduled:
H. Structural Software
I - N to be announced.

8:30-9:00 AM **Award Presentations**
Individuals who have rendered outstanding service to the structural steel industry will be honored.

9:00-9:15 AM **General Session: "Bridge & Structures Information Center"**
Speaker: Reidar Bjorhovde, University of Pittsburgh, Pittsburgh, PA

9:15-10:00 AM **General Session: "Case History – 27-story LRFD Office Building"**
Speaker: Lawrence G. Griffis, Walter P. Moore and Associates, Inc., Houston, TX
A major office building is framed in steel as a result of savings from an LRFD design. The particulars of the framing and floor systems will be described.

10:00-3:00 PM **Exhibits Open**
Lunch will be served beginning at 11:45 AM in the Exhibit Hall.

10:00-10:45 AM **Coffee Break (Exhibit Hall)**

10:45-12:15 PM **Technical Seminars** (See details on pp. 52-53)
1. Construction Claims
2. Products Liability Insurance
4. Frame Analysis, LRFD
5. Connection Design and Detailing
7. Recruitment and Training of Steel Detailers
17. Economical Bridge Design

11:45-1:30 PM Lunch Service Open

THURSDAY — MARCH 15 (Afternoon)

1:00-2:00 PM **Poster Session**
An exhibition of technical papers will be displayed near the entrance to the exhibit hall throughout the conference. Authors of papers will be available during this time period for discussion of the papers' contents.

2:30-4:00 PM **Technical Seminars**
3. What the First-line Supervisor Should Know
6. PR Connections
7R. Recruitment and Training of Steel Detailers
8. Plant Automation and Layout
10. Floor Serviceability and Constructability
11. Beam Camber

4:10-5:25 PM	**Technical Seminars** 1R. Construction Claims 12. Building Design 13. Tubular Connections 14. Connection Design Responsibility—Present Status 16. Economical Framing System 18. Fire Protection of Steel Frames
5:30-6:15 PM	**Exhibitor Workshops** Already scheduled: **O. Mountain Enterprises** P - U to be announced
7:00-7:45 PM	**Reception** (Cash Bar) - Mezzanine, Allis Plaza Hotel
7:45-10:00 PM	**Optional Event #2: Conference Dinner and Entertainment, "All That Jazz,"** Count Basie Ballroom, Allis Plaza Hotel

FRIDAY — MARCH 16

7:30-8:15 AM	**Exhibitor Workshops** - to be announced.
8:30-10:00 AM	**Technical Seminars** 2R. Products Liability Insurance 4R. Frame Analysis, LRFD 5R. Connection Design and Detailing 9R. Protecting Your Workers Against Welding Fumes 15. Scope of Business 17R. Economical Bridge Design
10:00-10:45 AM	**Coffee Break**
10:00-2:30 PM	**Exhibits Open**
10:45-12:15 PM	**Technical Seminars** 3R. What the First Line Supervisor Should Know 6R. PR Connections 8R. Plant Automation and Layout 10R. Floor Serviceability and Constructability 11R. Beam Camber 15R. Scope of Business
11:45 AM	Lunch Service Begins
12:15-3:00 PM	**Lunch/Exhibits Open**
3:15 PM	**EXHIBITS CLOSE - Exhibit Moveout begins**
3:00-3:45 PM	**General Session:** **T. R. Higgins Lecture** - winner to be announced
4:00-5:30 PM	**Technical Seminars** 9R. Protecting Your Workers Against Welding Fumes 12R. Building Design 13R. Tubular Connections 14R. Connection Design Responsibility 16R. Economical Framing System 18R. Fire Protection of Steel Frames
6:30-10:45 PM	**Optional Event #3 - Dinner Theatre** Dinner and show at the Waldo Astoria, combining good food, music and fun—pre-show entertainment, lively Broadway comedy.

SATURDAY — MARCH 17

8:30-9:30 AM	**General Session** "Unusual Steel Framing - 34-story Office Building in Kansas City: Block 111" **Speaker**//Design: **Charles R. Page,** Seiden and Page, Inc., Shawnee Mission, KS **Speaker**/Fabrication and Erection: **William L. Richey,** Havens Steel Company, Kansas City, MO
9:30-12:00 Noon	Choice of: **Optional Event #4 - Hard-hat Tour of Block 111** (No charge, but advance reservation required) **Optional Event #5 - Tour of Fabricating Plant** (No charge, but advance reservation required) **Optional Event #6 - Hard-hat Bridge Tour** (No charge, but advance reservation required)
1:00-4:00	**Optional Event #7 - Trip to Independence** Repeat of **Spouse's Event C**, *does not include lunch.*

SPOUSES' PROGRAM

Those registering for the COMPLETE Spouses' Program will receive tickets for **all** events listed below. Anyone wishing to register for any one or more of these events INDIVIDUALLY may do so by selecting Events A, B, C and/or D on the Conference Registration Form.

There will be no charge for spouses attending the Welcome Cocktail Party Wednesday evening in the Exhibit Hall.

EVENT A - Thursday morning, March 15: 11:30 - 1:00 PM
Secrets of the Stones - Following luncheon in the Count Basie Ballroom of the Allis Plaza Hotel, one of Kansas City's leading jewelers will reveal "secrets of the stones," a display and discussion of gems, their value, how to buy and clean them—showing breathtakingly beautiful jewelry pieces not normally seen outside stores.
Price (including lunch) $20.00

EVENT B - Thursday afternoon, March 15: 1:30 - 5:30 PM
Historical Weston Tour - Travel to the 1837 Missouri River town of Weston, Mo., for a visit to one of the town's more thatn 100 pre-Civil War (and lived-in) homes listed in the National Register of Historic Places, the Weston Historical Museum and a business section featuring many craft and antique shops.
Price (including bus and admissions) $16.00

EVENT C - Friday morning, March 16: 9:15 - Noon
Nelson Gallery/Kansas City Museum - tour of one of the most comprehensive art museums in the U.S., with art collections of all civilizations, from Sumeria 3,000 B.C. to modern painting and sculpture. Silver, furniture and period rooms, the Oriental collection from China; painting and pottery from Persia, screens and ceramics from Japan—plus the new outdoor sculpture garden. The Museum of History and Science, a 70-room mansion built by the lumber millionaire R. A. Long, now houses regional history exhibits, North American Indian artifacts, a showcase for costumes and textiles, and a planetarium.
Price (including bus and admission) $16.00

EVENT D - Friday afternoon, March 16: 12:30 - 4:30 p.m.
Trip to Independence - Buses will leave at 12:30 p.m., stopping for lunch at Stephenson's Apple Orchard, a charming and cozy, award-winning restaurant where country cooking is featured and President Harry S. Truman entertained heads of state—then to Independence, Mo. for a tour of the fiery and colorful Truman's hometown, highlighted by a visit to the Truman Library and Museum and, on the return trip, a drive by the massive Kansas City Royals/Chiefs Baseball/Football Stadium.
Price (including lunch, tips and admissions) $25.00

Complete spouses' program (includes A, B, C & D) $75.00

TECHNICAL SEMINARS

1 Construction Claims (Panel)

Moderator: Robert B. Nelson, AFCO Steel, Little Rock, AR
Speakers:
David B. Ratterman, Goldberg & Simpson, Louisville, KY
James R. Jones, Havens Steel Co., Kansas City, MO
Frank Goldenberg, Montague-Betts Company, Inc., Lynchburg, VA

2 Products Liability Insurance (Panel)

Moderator: Morris H. Caminer, AISC
Representative, CNA Insurance Company
Representative, Hiatt Agency, Inc.
Representative, AISC

Representatives of a major insurance company, national brokerage firm and fabricator share thoughts on common-sense approaches to purchasing insurance. Regardless of firm size, attendees will leave this session with cost-saving tips easily implemented in their business. Question-and-answer period follows presentation.

3 What the First-line Supervisor Should Know (Panel)

Moderator: Robert H. Woolf, Cives Steel Company, Roswell, GA
Dorman S. Conklin, Employee Development Services, Jackson, MS
James E. Self, Cives Steel Company, Roswell, GA

A workshop to give managers the information and skills they need to successfully implement participatory management in the production environment, nurturing the environment necessary to encourage, foster and maintain employee commitment and quality production. Self will discuss employee motivation and expectations, as well as legal restrictions impacting supervision of the workforce.

4 Frame Analysis, LRFD

Moderator: William McGuire, Cornell University, Ithaca, NY

"Second Order Elastic Analysis in LRFD - Research to Practice" - Donald W. White, Purdue University, West Lafayette, IN

"Studies in Inelastic Analysis and Design" - Ronald D. Ziemian, Cornell University, Ithaca, NY

Case studies from research directed towards advancement of inelastic building systems design includes a series of plane-frame studies; three-dimensional frame of compact sections, member vs. system behavior and illustrations of force redistribution as calculated by inelastic analysis programs.

5 Standard Details and Connections

"— in Buildings" - **Cynthia Zahn,** AISC, Chicago, IL
"— in Bridges" - **Charles L. Chambers,** FHA Region 3, Baltimore, MD

AISC has developed new design aids for pre-engineered web bolted connections. Zahn will describe those aids in detail. FHWA Region 3 has developed standard specifications and design details for steel bridges. The acceptance and use of the adopted standards have been encouraging.

6 PR Connections

Moderator: Robert F. Lorenz, AISC, Chicago, IL

USA - **Gregory G. Deierlein,** Cornell University, Ithaca, NY

Europe - **Ricardo Zandonini,** University of Trento, Italy

Speakers will describe international developments in the theory and practice of Partially Restrained Connections in LRFD.

7 Recruitment and Training of Steel Detailers (Panel)

Moderator: Terry Peshia, Garbe Iron Works, Aurora, IL

Speakers:
Al Frechette, Executive Director, Great Lakes Fabricators Association
Ken Volte, Paxton-Vierling Steel Company, Omaha, NE
Leonard Ross, L. N. Ross Engineering Co., Atlanta, GA

One of the key limiting factors of a fabricator's ability to expand and be successful is the capacity to quickly produce accurate shop drawings. The solution to this potential problem is recruiting and training of qualified detailers. Ideas and solutions from the perspective of a fabricator, a detailing service company and a structural steel trade organization will be presented to stimulate thought on the variety of things which must be done to resolve this major concern.

8 Plant Automation and Layout

Moderator: Sidney W. Blaauw, Paxton & Vierling Steel Company, Omaha, NE

Charles B. Jensen, Jensen Engineering & Machinery Company
Fred Kohler, Paxton & Vierling Steel Co., Omaha, NE

9 Protecting Your Workers Against Welding Fumes (Panel)

Moderator: W. H. Reeves, Carolina Steel Company, Greensboro, NC

10 Floor Serviceability and Constructability

"Composite Construction" - Robert Leon, University of Minnesota, Minneapolis, MN

"Innovative Floor Systems" - Thomas H. Murray, Virginia Tech, Blacksburg, VA

11 Beam Camber

"Producer's Viewpoint" - Jay W. Larson and **Robert K. Huzzard,** Bethlehem Steel Corporation, Behtlehem, PA

"Fabricator's Viewpoint" - Lawrence A. Kloiber, L. L. LeJeune Company, Minneapolis, MN

Use of lighter, high-strength steel beams spanning greater distances produces more economical steel frames, but also results in larger deflections to be accommodated: several recent projects and field-measured data support suggested guidelines for understanding, specifying and implementing cambering, evaluating cost effectiveness and specifying cambering.

12 Building Design

"Steel Plate Shear Walls" - Mohamed Elgaaly, University of Maine, Orono, ME

Steel savings of as much as 50% have been achieved employing steel plate shear walls rather than moment-resistance frames. Results of new research on seismic behavior of thin steel plate shear walls at the University of Maine is presented.

"Interaction of Cladding and Steel Frame" - Stan Korista, Skidmore, Owings & Merrill, Chicago, IL

13 Tubular Connections (Panel)

Moderator: David T. Motyll, Welded Tube Company of America, Chicago, IL

Speakers:
Fred Palmer, American Institute for Hollow Structural Sections, Pittsburgh, PA

J. W. Post, J. W. Post Associates, Inc., Humble, TX

Palmer (director and consulting engineer for the newly created American Institute for Hollow Structural Sections) will review current state of tubular member design, design criteria, manufacture and typical applications; Post will focus on fabrication practices and techniques in the preparation, fit-up and welding of box-tube connections.

14 Connection Design Responsibility - Present Status

Moderator: Phillip Levine, Roll Form Products, Inc., Boston

Speakers:

Representative, AISC Staff
Representative, ASCE Staff

15 Panel: Scope of Business, including the following:

Erection - Subcontract vs. Erect Yourself
Freight - Contract-hauler vs. Your Trucks
Drafting - Subcontract Detailing vs. In-house Drafting

Moderator: Terry Peshia, Garbe Iron Works, Inc., Aurora, IL

Speakers:

Ray Jasica - PDM, Melrose Park, IL
Jack D. Wickliffe - Almet Corporation, New Haven, IN
Robert D. Long, Bratton Corporation, Kansas City, MO

At its core, the steel fabrication business is a manufacturing operation in a factory environment. There is, however, a difference in the in-house services offered by fabricators. Drafting, trucking and erection may be done directly by the fabricator or may be furnished by subcontractors. The questions are: Why does the fabricator choose to provide one service and not another? How did that function evolve?

16 Composite Members

"Trusses" - D. J. Laurie Kennedy, University of Alberta, Edmonton, Alberta, Can.

"Long-span Composite Joists" - Kurt D. Swensson, Stanley D. Lindsey Associates, Nashville, TN

Outlines design and construction of Sovran Bank Building, Knoxville, a 6-story parking structure topped by 8 stories of offices. Composite joist system made the project viable and brought the job in under budget.

17 Economical Bridge Design

"Route 150 Bridge over James River" - Steven J. Chapin, Hayes, Seay, Mattern & Mattern, Roanoke, VA

Steel Box Girder - I-95/I-595 Interchange in Florida" - Bogdan O. Kuzmanovic, Beiswenger, Hoch & Associates, North Miami, FL

Chapin will describe the design and construction of dual 4,233-ft bridges that carry Virginia Rt. 150 over the James River, the historic Kanawaha Canal and railroad tracks of CSX Transportation. Kuzmanovic will discuss design and erection of the curved, continuous composite hybrid box girders (spans ranging from 100 to 205 ft) for the I-95/I-595 Interchange in Florida.

18 Fire Protection of Steel Frames

"Effect of End Restraint" - Boris Bresler - Wiss, Janney, Elstner Associates, Emeryville, CA

Guidelines are proposed to aid designers of fireproofing for steel-framed buildings in identifying restrained and unrestrained construction.

"Fire Endurance, Case Studies" - Kathleen H. Almand - American Iron & Steel Institute, Washington, DC

"Load Combinations for Buildings Exposed to Fire" - Bruce Ellingwood - Johns Hopkins University, Baltimore, MD

An improved methodology for determining loads and load combinations for use in fire-resistant structural design is presented (consistent with European limit-states design approaches and compatible with LRFD philosophy).

OPTIONAL EVENTS

EVENT #1 - Wednesday morning, March 14: 9:30 - Noon
Tour of Kansas City - A bus tour through the "Heartland of America" to view the beauty and grace of hundreds of lovely fountains (more than any other city in the world except Rome) and statues, the first settlement of the Missouri and Kansas River, Crown Center, the Liberty Memorial, historic Westport—last outpost of the Santa Fe and Oregon trails, the affluent Mission Hills estate area and the Country Club Plaza, first U.S. suburban shopping community.
Price (including guide) $10.00

EVENT #2 - Thursday evening, March 15: 7:45 - 9:30 PM
All that Jazz (Conference Dinner and Show) - The Count *Basie Ballroom of the Allis Plaza hotel makes an ideal setting* for dinner (Kansas City sirloin steak, of course) followed by a show that includes all the varieties of American jazz for which Kansas City is known: blues, ragtime, Dixieland, swing. (Open reception with cash bar immediately preceding dinner in the Ballroom Foyer, Mezzanine Level.)
Price (dinner, tip and entertainment) $37.00

EVENT #3 - Friday evening, March 16: 6:30 - 10:45 PM
Dinner Theatre - Dinner and show at the Waldo Astoria, a delightful and nostalgic theatre featuring oil paintings and posters of the "greats" of yesteryear, opera boxes and tiered floor seating. Evening includes marvelous pre-show entertainment, a lively Broadway comedy and gourmet buffet (drinks "on your own").
Price (transportation, buffet, show, tax & tips) $30.00

EVENT #4 - Saturday morning, March 17: 9:30 - Noon
Hard Hat Tour of Block 111 - An on-site visit to the construction side of the Kansas City steel-framed highrise featured in the morning general session.
(No charge, but advance reservation is required)

EVENT #5 - Saturday morning, March 17: 9:30 - Noon
Tour of Fabricating Plant - Two Kansas City area structural steel fabricators will open their plants for guided tours—buses will load on first-come, first-served basis; number of buses to be accommodated may be limited due to plant safety requirements.
(No charge, but advance reservation is required)

EVENT #6 - Saturday morning, March 17: 9:30 - Noon
Hard-hat Bridge Tour - Arrangements are now underway to visit one of the steel-framed bridges in the Kansas City area; site to be announced.
(No charge, but advance reservation is required)

EVENT #7 - Saturday afternoon, March 17: 1:00 - 4:00 PM
Trip to Independence - Buses will leave at 1:00 for *Independence, Mo. and a tour of the fiery and colorful Harry S* Truman's hometown, highlighted by a visit to the Truman Library and Museum and, on the return trip, a drive by the massive Kansas City Royals/Chiefs Baseball/Football Stadium.
Price (including admissions) $12.00

CATCH THE K.C. TROLLEY FOR ON-YOUR-OWN FUN

The Kansas City Trolley ($3 fare good for three rides in one day) stops at the Barney Allis Plaza (less than one block from any of the Conference Hotels), traveling to:

Crown Center - a complete urban community offering speciality shopping, fun-to-fancy restaurants, movies, live Broadway-style theatre and the Hallmark Visitors Center;

Westport Marketplace - a thriving area reminiscent of the 19th century, with shops, restaurants and boutiques.

REGISTRATION FORM

Registration Fees: (Please circle appropriate fees)

AISC Member Fee: $275.00 (before February 1)
$325.00 (After February 1)
(Includes AISC Active, Associate & Professional Members)

Non-Member Fee: $325.00 (before February 1)
$375.00 (after February 1)

Educator fee: $100.00
(Employed full-time at accredited architectural or engineering college or university.)

Student Fee: $ 75.00
(Letter from faculty advisor or equivalent required)

Exhibitor, in Booth (no charge)

Added Exhibitor: $ 75.00

Spouse's Fee: $ 75.00

Registration Fees Include all General and Plenary Sessions, workshops, seminars, coffee breaks, luncheons Thursday and Friday, the Get-acquainted Cocktail Reception Wednesday evening and a printed, bound copy of the Proceedings. Exhibitors are entitled to one registration for each 10-ft × 10-ft exhibit space reserved. "Added Exhibitor" fee is payable **ONLY** if in excess of one person per 10-ft × 10-ft.

Registration Cancellation Policy: Cancellations received before March 9, 1990, 100% of pre-paid registration fees will be refunded; after March 9, 50% will be refunded. (Those cancelling after March 9 will receive their copy of the Conference Proceedings.)

Partial Registration Fees

(You may also pre-register for one day or half day. Circle your choice below.)

Half Day Sessions: (Lunch not included)	
Wednesday Afternoon	$ 50.00
Thursday Morning	$ 65.00
Thursday Afternoon	$ 65.00
Friday Morning	$ 65.00
Friday Afternoon	$ 65.00
Saturday Morning	$ 25.00
One Day Sessions:	
Thursday (includes Lunch)	$150.00
Friday (includes Lunch)	$150.00
Exhibitor Visitor:	$ 5.00
Total Partial Registration Fees	**$**______

Registration for Optional Events

Event	No Tickets	Total Price
#1—Kansas City Tour (Wed., 9:30 a.m.)	___@ $10.00	$ ______
#2—Jazz Show/Dinner (Thurs., 7:45 p.m.)	___@ $37.00	$ ______
#3—Dinner Theatre (Fri., 6:30 p.m.)	___@ $30.00	$ ______
#4—Tour, Block 111 (Sat., 9:30 a.m.)	___@ No fee	
#5—Tour Fab. Plant (Sat., 9:30 a.m.)	___@ No fee	
#6—Tour Steel Bridge (Sat., 9:30 a.m.)	___@ No fee	
#7—Independence (Sat., 1:00 p.m.)	___@ $12.00	$ ______
#A—Secrets of the Stones (w/lunch) (Thurs., 11:30 a.m.)	___@ $20.00	$ ______
#B—Weston Tour (Thurs., 1:30 p.m.)	___@ $16.00	$ ______
#C—Nelson Gallery/K.C. Museum (Fri., 9:15 a.m.)	___@ $16.00	$ ______
#D—Independence (w/lunch) 12:30 p.m.	___@ $25.00	$ ______
Total Optional Event Fees		**$** ______

PLEASE REGISTER (Type or Print)

Name __________ Nickname (for badge) __________

Company __________ Title __________

Mailing Address __________

City and State/Zip __________ ( ) Bus. Phone ______ ( ) Home Phone ______

If spouse or other guest is registering for Complete Spouse's Program, or individual Spouses' or Optional Events, please complete next line for badge:

Name of Individual Registering for Other Events __________ Nickname (for badge) __________

Conference Fees Payable:

Registration Fee:	$ ______
Spouse's Fee:	$ ______
Partial Registration Fees:	$ ______
Optional Events:	$ ______
Total Registration Fees:	**$** ______

___ I enclose check (U.S. funds) payable to AISC in amount of total fees.

___ Please charge my credit card # __________
Visa or MasterCard only—Circle one: VISA MasterCard

Expiration Date (Month and Year) __________
Signature (if any credit card charges):

____

MAIL COMPLETED FORM AND CONFERENCE FEES TO:

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1990 National Steel Construction Conference
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