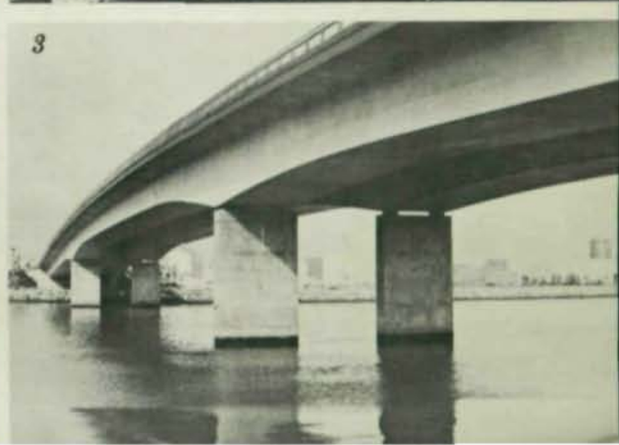
VOLUME XI / NUMBER 3 / THIRD QUARTER 1971

MODERN STEEL CONSTRUCTION



MODERN STEEL CONSTRUCTION

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THE T. R. HIGGINS LECTURESHIP AWARD

In 1972, the American Institute of Steel Construction will conduct the second annual T. R. Higgins Lectureship Award. The Award honors former AISC Director of Engineering and Research Theodore R. Higgins for his substantial contributions to the advancement of the structural steel industry through innovative engineering, technical papers, and professional lectures.

The Award recognizes the author of the technical paper that is judged to be the most significant contribution to engineering literature on fabricated structural steel published within the period from July 1, 1969 to July 1, 1971. The Award consists of an engraved certificate and a $2,000 honorarium. If the paper selected has more than one author, the principal author listed will receive the Award, but the other authors will also be honored. Presentation of the Award will be made at the AISC National Engineering Conference, to be held in New York City, May 4 and 5, 1972, where an oral review of the prize-winning paper will be presented by the author.

1972 FELLOWSHIP AWARDS

Entries are invited for AISC's Tenth Annual Fellowship Awards Program. These awards serve to encourage expertise in the creative use of fabricated structural steel.

Four $2,500 fellowship awards will be granted to senior or graduate students enrolled in a structural engineering program at an accredited engineering institution. Additionally, the head of the department where each Fellow will undertake his study will receive a further grant of $500 for unrestricted general administrative use.

Students interested should contact the Education Committee, AISC, 101 Park Avenue, New York, N. Y. 10017 for the Rules and Instructions for Applicants.

A View from the Bleachers

by Joseph R. Warlick, Jr.
AISC Regional Engineer
Atlanta, Ga.

Today's stadium is a massive structure of steel and concrete, which covers an entire city block and is as tall as a 12-story building. Inside this structure, services must be provided to accommodate a population equal to that of a city of 50,000 to 70,000 people, as well as caring for their comfort and pleasure.

The word *stadium* evolves from the Greek. The original meaning applied to a measure of distance equal to about 606 ft. Later, this term designated the race course on which such a distance was laid out. This course was usually flanked with terraced seats where spectators went to cheer their favorites. Finally, the name was applied to the entire layout.

The race course or stadium at Olympia, Greece, was constructed in the Third Century, B. C. Stone seats along the sides were joined at one end to form a semi-circular curve. The Romans built their stadia in a most elaborate fashion. The famous Circus Maximus still holds the record for being the largest stadium ever constructed, with accommodations for 250,000 spectators.

The Roman Coliseum was built from 72 to 80 A. D., the period when Roman architecture and engineering had reached their zenith.

This four-story oval holds 50,000 spectators, and shows that such items as sight line clearances were a major consideration in its construction. Aisles and exits were arranged in the same manner as we practice today.

With the decline of the Roman Empire, stadia construction became a lost

Busch Stadium, St. Louis, Mo.

San Diego Stadium

art for nearly twelve centuries. In the United States prior to 1900, no known stadium facilities were in existence. Up until World War I, this country's stadia numbered five. In 1912, the U-shaped Harvard Stadium was built. The Yale Bowl went up in 1914 and exceeded the 50,000 seating capacity of the Roman Coliseum; it holds 70,900.

Following World War I, an epidemic of stadium construction spread through the colleges and municipalities. By 1930, over 100 large stadia had been built, mostly for football. The horseshoe shaped stadium at Ohio State University was constructed in 1922. The Los Angeles Coliseum was built in 1923, and enlarged in 1932 to hold 105,000 for the 1932 Olympics. The JFK Stadium, in Philadelphia, (formerly Municipal Stadium) seats 102,000, and was built in 1926. Soldiers Field in Chicago went up in the same year. The University of Michigan Stadium, built in 1927 and enlarged in 1949 and 1956, has a capacity of 101,000.

In the late 30's and 40's interest in the stadium again ebbed, and with World War II, stadium building stopped. It was not until the late 50's that interest revived. As a result of the popularity of professional football and baseball, a new interest was taken in updating existing facilities. Progressive-minded cities realized that to maintain their sports franchises or to attract new franchises they must provide new and modern facilities.

San Francisco started it all with Candlestick Park, built primarily for baseball in 1958. Subsequently, in 1959, work began on the 56,000-seat Chavez Ravine stadium in Los Angeles, also designed for baseball.

The first multi-purpose stadium came in 1963. The District of Columbia Stadium, now known as the Robert F. Kennedy Stadium, was the first stadium designed for baseball and football. Also, this stadium demonstrates the first use of rotating sections to afford the best view for both sports by rearranging the seating. This concept, developed by Engineers-Architects, Praeger-Kavanagh-Waterbury, subsequently has been used in Shea Stadium, New York, the Houston Astrodome, Three Rivers Stadium in Pittsburgh, and Riverfront Stadium in Cincinnati.

Playing Surface

In the mid-60's, artificial turf was developed for use in the Astrodome. Since then most stadia have been using an artificial turf. Cincinnati's Riverfront Stadium and Busch Stadium, in St. Louis, both have Astroturf. Cincinnati employed 126,500 sq ft of Astroturf at a cost of approximately $560,000. Three Rivers Stadium in Pittsburgh features the more recently developed Tartan Turf.

The future will continue to see more of the major league stadia providing an artificial playing surface. Atlanta has been considering this change for some time, and will probably convert their field in the near future.

Scoreboard

Today, a big league scoreboard cannot simply give hits, runs, scores, etc., it must also be able to project electronic messages instantly and provide interesting animated sequences for the public's enjoyment.

As in other aspects of the stadium, scoreboards seem to be getting bigger and better.

When the Robert F. Kennedy Stadium opened, it advertised "the most modern and complete scoreboard," 369 ft long by 40 ft high. The Three Rivers

Veterans Stadium, Philadelphia, Pa.

Oakland Stadium

scoreboard is 274 ft long and 30 ft high and cost well over $1-million. Riverfront in Cincinnati has a board 180 ft long and 20 ft high, and it stands 150 ft above the playing surface. It cost approximately $1.1 million. The new Veterans Stadium in Philadelphia claims the "world's largest computerized scoreboard system" and will include two 100-ft by 25-ft baseball scoreboards.

Lighting

The increase of sporting events held after dark, as well as the lighting requirements of color television, has necessitated close attention to stadium lighting.

Riverfront Stadium boasts the "brightest lights in baseball." These include nearly 1700 1000-watt Mitalarc lamps which create conditions comparable to daylight in both brightness and color rendition. At Riverfront, the units are installed in a light ring approximately 150 ft above the playing surface. Lighting levels for both baseball and football will average 250 foot-candles. Color television requires a minimum of 225 foot-candles.

Movable Sections

Praeger-Kavanagh-Waterbury solved one of the major problems of multi-purpose stadia with the development of movable seating. This type of seating allows the spectator to get as close to the field in as comfortable a seat as possible, and to have the most ideal view of the field for baseball and football.

With the Robert F. Kennedy Stadium taking the lead, the majority of recent stadia have used the movable seat concept. In the RFK Stadium, only one section of seats can be rotated. However, in Shea Stadium and the Astrodome this concept was expanded to two rotating sections.

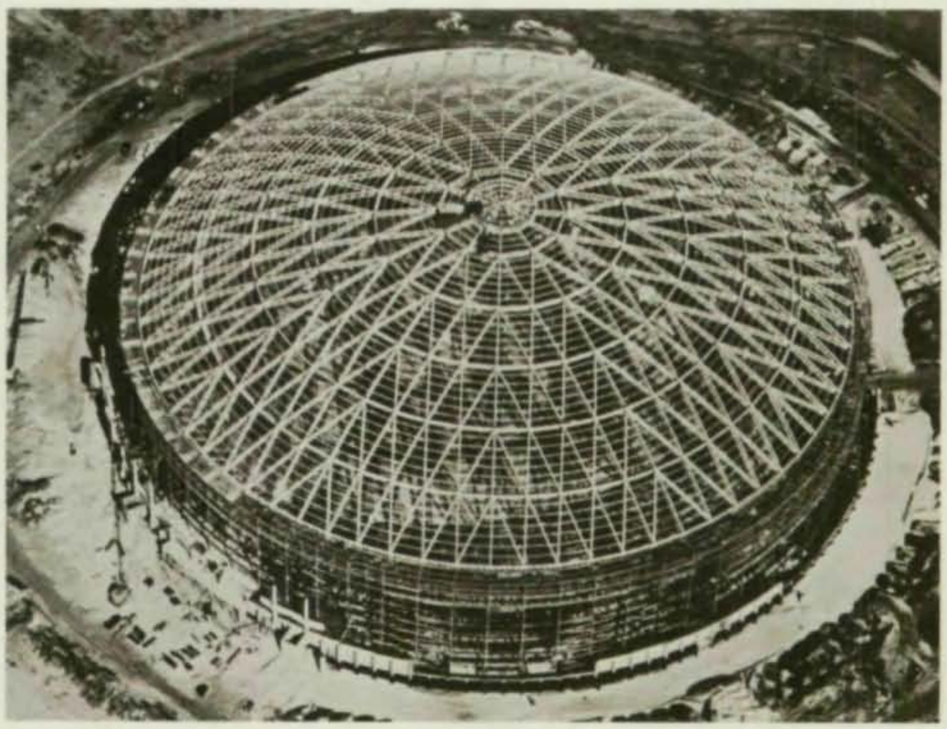
Seating

The American public is spoiled so far as comfort and convenience are concerned. The more recent multi-purpose stadia have taken this into consideration in selecting the seating. In 1927, when Yankee Stadium was built, 18- and 19-in. wide seats were provided. In the Riverfront Stadium, 21- and 22-in. wide seats are provided. Similarly, Three Rivers Stadium has 22-in. wide theater type seats.

The Future

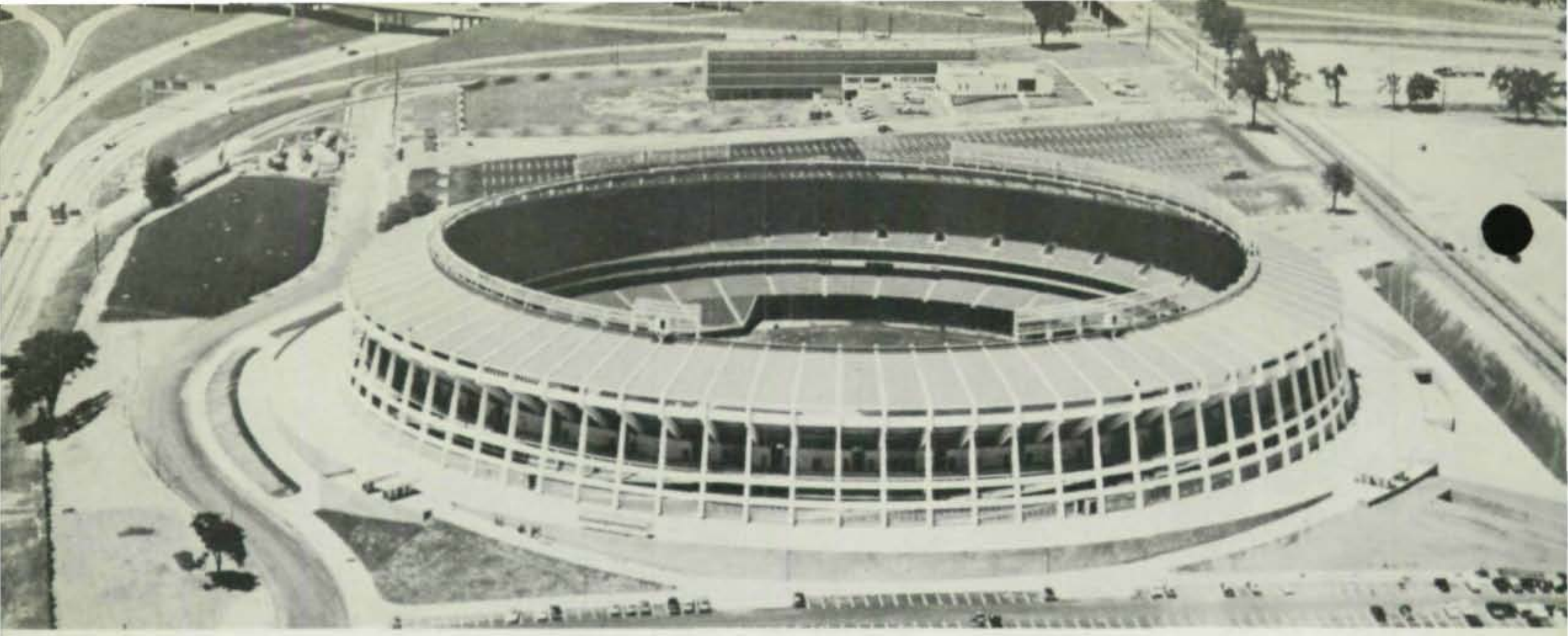
The Astrodome concept signalled that a new era in stadium construction had been reached. Several cities had dreams of retractable roof structures, but had to settle for something far less. The Astrodome has served as a model for other stadia for several years now, but it will finally get some competition. The Louisiana Stadium in New Orleans will be a 680-ft Lamella dome with a reported seating capacity of 72,000. It will rise from the playing

Houston's Astrodome



Shea Stadium, Flushing, New York

Three Rivers Stadium, Pittsburgh, Pa.



Atlanta Stadium

field to a height of 276 ft-6 in. at the center. This will outdo the Astrodome which is 641 ft-8 in. in diameter and 213 ft high. From all reports, the Louisiana Stadium will cost approximately $150-million.

Atlanta has already invested approximately $400,000 for air-conditioning ducts and has added foundations for a roof covering sometime in the future. Shea Stadium also was designed to carry a future roof cover.

Detroit, at present, is developing preliminary studies for a roofed stadium. Possibly, the future will see a flurry of roofed multi-purpose stadia.

Cost

Since ground was broken for the first multi-purpose stadium (RFK Stadium) in 1960, the cost of construction has jumped over 50 percent. Kennedy Stadium cost $19.8-million to construct at a cost of $403 per seat for the basic stadium. This figure does not include all of the luxuries of today's stadium, which comes equipped with a $1.5-million message center, artificial turf at a cost of $500,000 to $800,000, boat docks, and mass transit centers as an integral part of the stadium. Escalators, people movers, and parking structures for well over 1500 cars are also required.

The Atlanta Stadium, completed in 1964, still holds the distinction of being the most economical multi-purpose stadium ever built. The cost per seat was $284, and the overall cost came to approximately $18-million. However, it has none of the frills, such as artificial turf, movable seating, or million dollar scoreboards.

Comparative Data

Table 1 compares most of the multipurpose stadia throughout the country. The cost data shown here is approximate. The estimated cost figures represent the actual construction cost including site work, exclusive of parking structures, off-street and highway work. Costs are adjusted to the U. S. Average Index, 1st Quarter of 1971.

Appreciation is extended by the author to Mr. Wilton L. Ferguson, Project Manager, Heery and Heery — Finch, Alexander, Barnes, Rothschild and Paschal, Associated Architects, for much of the information and data provided.

Robert F. Kennedy Stadium, Washington, D.C.

TABLE I

MULTI-PURPOSE STADIUMS COMPLETED TO DATE IN U.S.A.[a] ⊕Concrete framed

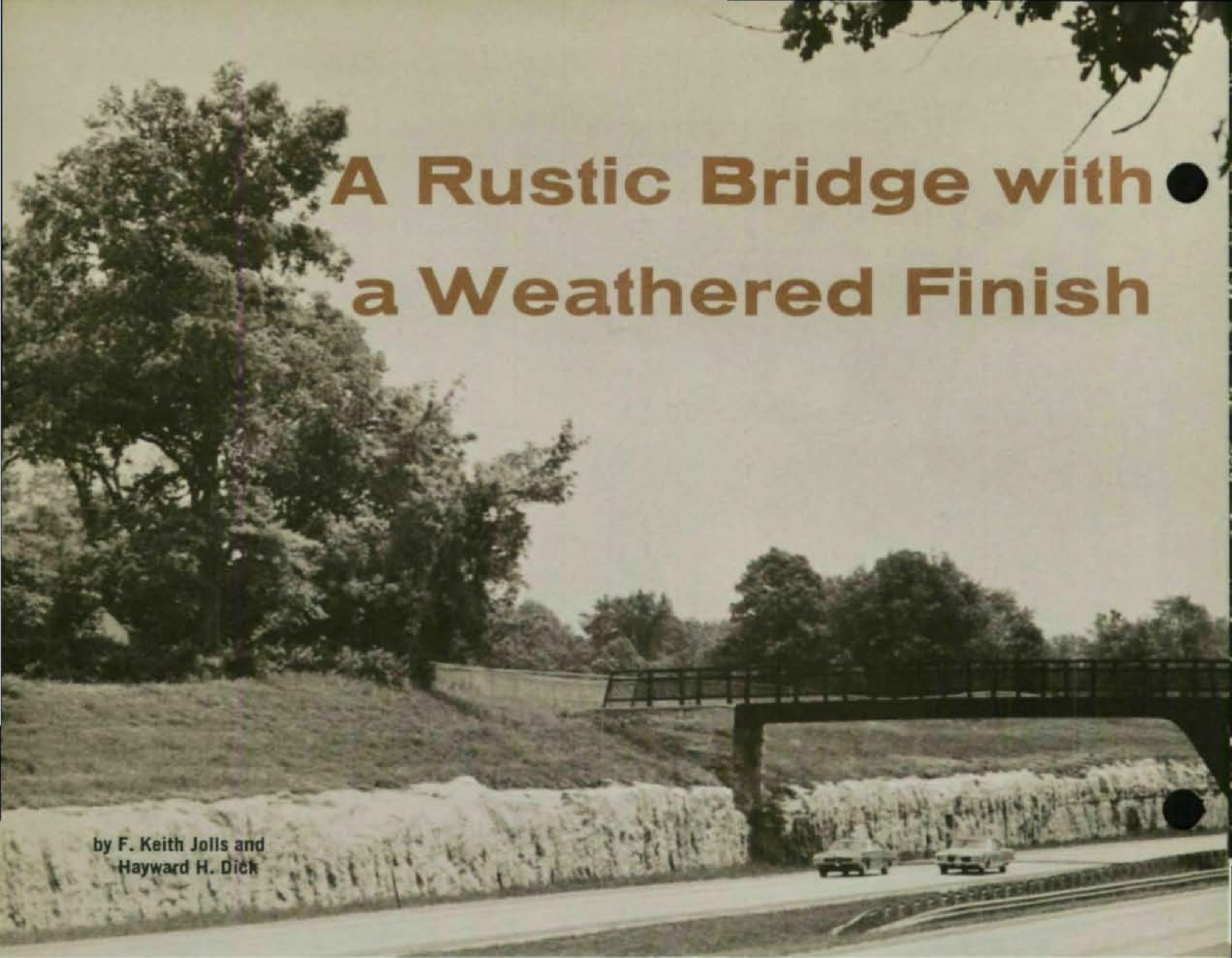
STADIUM	CONSTRUCTION COST[b] IN MILLIONS	SEATING CAPACITY (BASEBALL)	COST PER SEAT	CONSTRUCTION COST ADJUSTED TO THE U.S. AVERAGE INDEX FOR 1st QUARTER 1971	COST PER SEAT ADJUSTED TO THE U.S. AVERAGE INDEX FOR 1st QUARTER 1971
ATLANTA	$14.6	51,383	$284	$22.1	$430
BUSCH (St. Louis)	$28.5	50,126	$568	$39.7	$792 *
RIVERFRONT (Cincinnati)	$26.0	51,744	$502	$31.5	$609
ASTRODOME[c] (Houston)	$35.5	45,000	$709	$54.0	$1200
KENNEDY (Washington)	$19.8	45,016	$403	$31.0	$686
OAKLAND	$18.0	50,000	$360		
VETERANS (Philadelphia)	$39.7	50,000	$709	$55.3	$1160 *
THREE RIVERS (Pittsburgh)	$35.0	50,235	$696	$41.6	$821
SAN DIEGO	$20.4	50,000	$401	$28.8	$576 *
SHEA (New York)	$21.0	55,300	$328	$33.8	$611

a. Based on a table prepared by Heery and Heery — Finch, Alexander, Barnes, Rothschild and Paschal, Associated Architects, dated March 1968, updated and expanded by the author, May 1971.

b. Construction costs are estimated, including site work and all extras, but excluding parking facilities, off-site street and highway work.

c. Including dome and air conditioning.

Riverfront Stadium, Cincinnati, Ohio



A Rustic Bridge with a Weathered Finish

by F. Keith Jolls and Hayward H. Dick

Why does a horse cross the road?

In Louisville, Kentucky, the answer is easy. Because there is a bridle path bridge spanning it.

The new Interstate I-64 traverses a municipal park that is bordered by a golf course and a riding club. This highway lies in a relatively deep rock cut, and completely severed access of the riding club to several miles of developed trails, and was a hazard to pedestrians seeking access to portions of the park.

Charles G. Cook, Director, Division of Bridges, and Guy F. Vansant, Junior Assistant of Program Management, both of the Kentucky Department of Highways, took note of this problem and called in Vollmer Associates, Engineers and Landscape Architects, to design a bridge restoring full access to the recreational facilities of the area.

Steel was chosen over concrete as the preferable material for this narrow equestrian span.

The adaptability of steel to cutting and welding permitted the efficient placement of material for maximum effective functioning. The resulting girder bridge, built of A242 steel, is supported at the ends by recessed stone faced abutments, and at the center by slender V-shaped legs which join to the girders with graceful curved haunches. The clean, sophisticated lines of this bridge do much to enhance and complement the surrounding terrain.

The bridge spans 80 ft each side from center pier to the abutments and contains slightly over 41 tons of weathering steel. It is designed for a live load of 60 lbs psf, together with an impact factor of 30 percent. The depth to span ratio has been held to 1:24, which is conservative; live load deflection, considered critical, has been limited to 1:1200 in order to preclude excessive vibration; and slight overdesign allowed for whatever minor corrosion loss might occur until the tight oxide of the weathering steel developed.

The girders are W36X135 rolled beams, and the rigid leg center portion is shop welded from web and flange plated of equal thickness to those of the girders. All stiffener plates and connections have been placed on the inside of the webs, leaving the outside face smooth and uninterrupted. (Verti-

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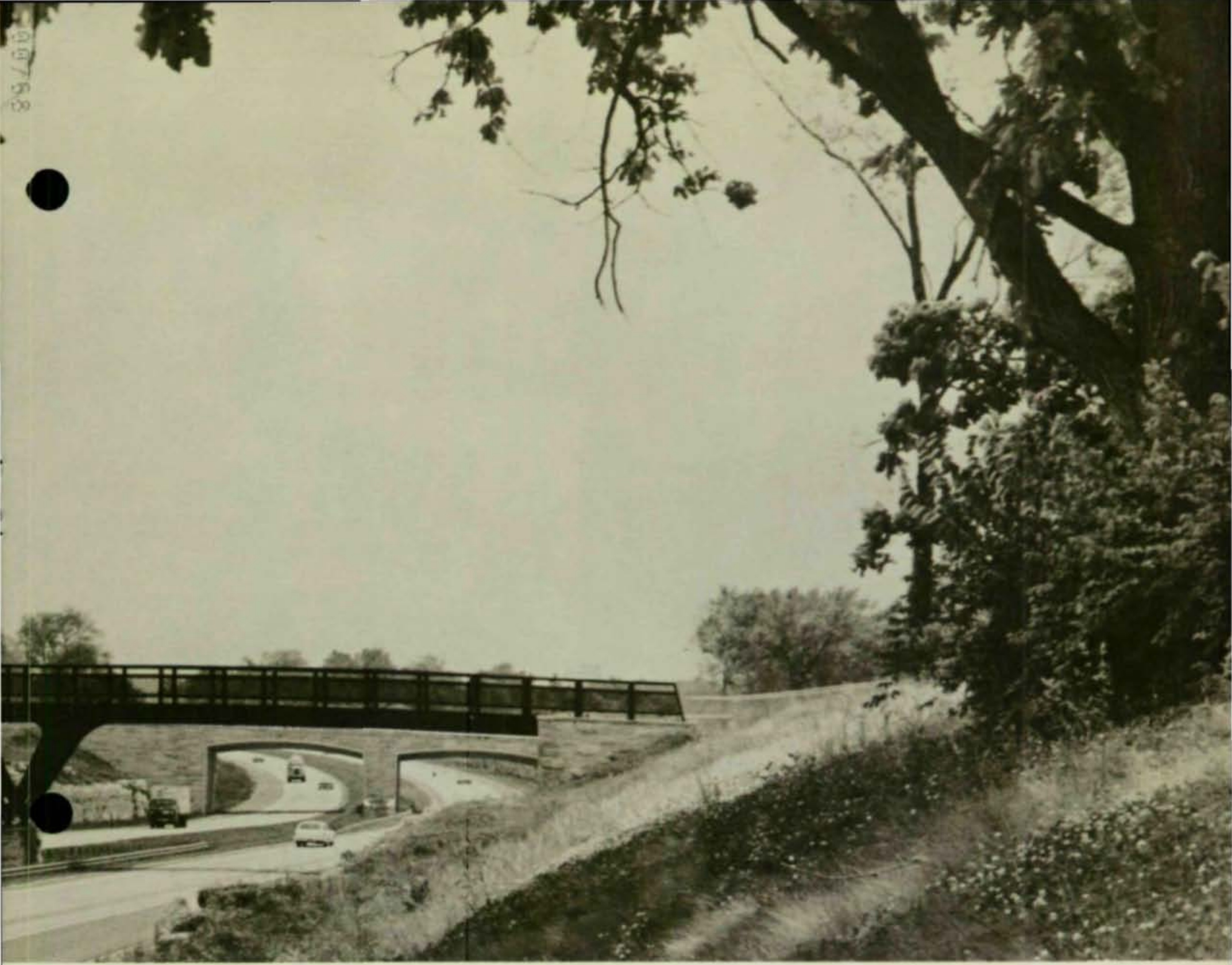
Mr. Jolls of Vollmer Associates, New York, N.Y., was partner-in-charge of design of this bridge. AISC Regional Engineer Dick is based in Columbus, Ohio, and serves the Louisville area.



cal connection plates at the cross frames also serve as knee bracing for the compression flanges.)

The main girder splices (at the dead-load inflection points) were butt-welded in the field after special joint preparation. The only other field welding required was at the base plates of the railing posts and the bottom chord diaphragms at the pier. Temporary bolts facilitated erection procedures and insured proper alignment, and were then encased in the concrete curb.

Bearing is fixed at the pier, with 8-in. dia. end plates welded to the 3-in. bearing pin at the fixed shoe to emphasize the articulation. Expansion takes place at the abutment, and the expansion bearings are concealed by stone cheek walls.

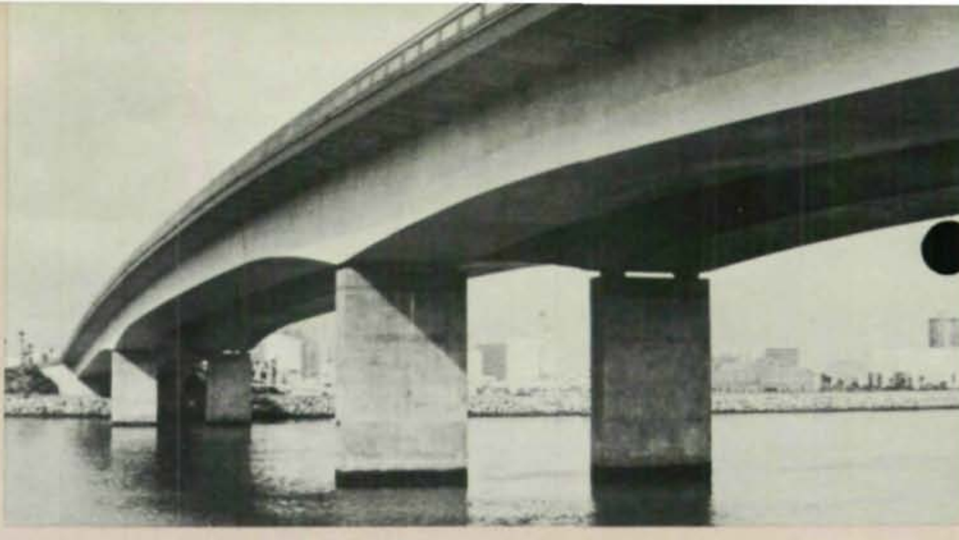
The design of the superstructure is similar to that of a through girder with a concrete slab. The cross framing consists of 8 x 8-in. structural tees built up of 3/8-in. plate, spaced 11 ft apart, supporting a 12 ft wide concrete slab 8 in. thick. The slab rests on the lower flanges of the girder, the upper part thus serving as a parapet and effectively lowering the height of railing required. It is covered with a 1/2-in. rubberized mat which was developed especially for use around racetracks. The railings, designed for lateral stiffness, extend 7 ft-6 in. above the deck. They are built of A242 rectangular tubing, plate, and expanded metal.

Care was given to avoiding staining until the tight oxide layer developed:

- The bridge, on a vertical curve, insures runoff to each abutment.
- At the pier, a stone coping extends above and around the top of concrete, which slopes to the center drain.
- Drip bars are provided on the bottom flanges of the girders near the abutments, where raised copings and drains are likewise provided at the bridge seat.
- The rail posts on the wingwalls are set in pockets to drain away from the stone fascia.
- The inside faces of the concrete deck curbs were given a coating of stain and linseed oil to match the weathered color of steel.

The choice of weathering steel gives relative freedom from maintenance. This economic material's final dark russet color will be in perfect compatability with the terrain.

PRIZE BRIDGES OF 1971



PRIZE BRIDGE 1971 — LONG SPAN
Queen's Way Bridge
Long Beach, California
Designers: M. A. Nishkian & Co., Consulting Engineers
John K. Minasian, Structural Engineer
Owner: City of Long Beach
General Contractors: Superstructure: Murphy Pacific Corporation
Substructure: Guy F. Atkinson Company
Steel Fabricator: *Murphy Pacific Corporation*

PRIZE BRIDGE 1971 — MEDIUM SPAN, HIGH CLEARANCE
Klamath River (South Rogers Creek) Bridge
Siskiyou County, California
Designer: California Division of Highways
Owner: State of California
General Contractor: The William Simpson Construction Company, Div. of Dillingham Corporation
Steel Fabricator: American Bridge Div., U. S. Steel

PRIZE BRIDGE 1971 — MEDIUM SPAN, LOW CLEARANCE
New Croton Reservoir Bridge
Westchester County, New York
Designer: Blauvelt Engineering Co.
Owner: East Hudson Parkway Authority, State of New York
General Contractors: Mt. Vernon Contracting Corp.
Colonial Asphalt Paving Corp.
Steel Fabricator: Bethlehem Steel Corporation

PRIZE BRIDGE 1971 — SHORT SPAN
Blanks Mill Bridge Across Rocky River
Warren and Van Buren Counties, Tennessee
Designer: Tennessee Valley Authority
Owners: Van Buren and Warren Counties
General Contractor: Tennessee Valley Authority
Steel Fabricator: Nashville Bridge Company

PRIZE BRIDGE 1971 — HIGHWAY GRADE SEPARATION
Genesee Interchange
I-70, Jefferson County, Colorado
Designer: Division of Highways, State of Colorado
Owner: State of Colorado
General Contractor: H-E Lowdermilk Co.
Steel Fabricator: Kansas City Structural Steel Company

PRIZE BRIDGE 1971 — ELEVATED HIGHWAYS OR VIADUCTS

Bluff Freeway Bridges
Kansas City, Missouri

Designer: Howard, Needles, Tammen & Bergendoff
Owner: Missouri State Highway Commission
General Contractor: Ted Wilkerson, Inc.
Steel Fabricator: American Bridge Div., U. S. Steel

PRIZE BRIDGE 1971 — SPECIAL TYPE

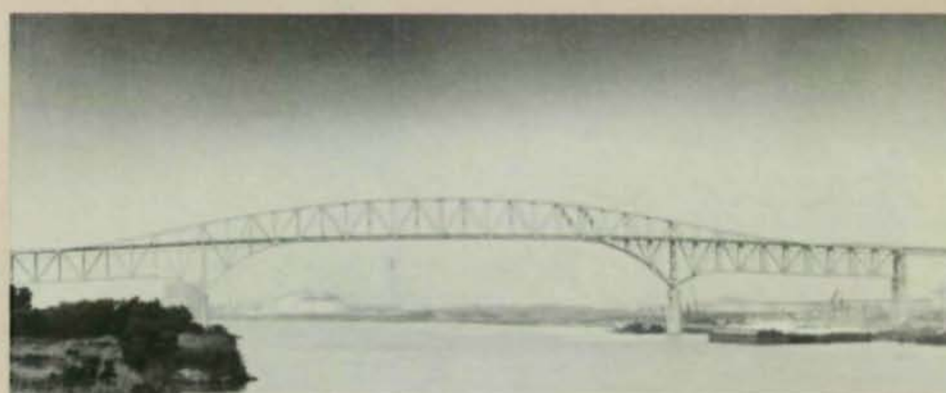
Buttermilk Springs Bridge
Richmond, Virginia

Designers: Carlton Sturges Abbott
Torrence, Dreelin, Farthing & Buford
Owner: City of Richmond
General Contractor: J. A. Walder Contractor, Richmond, Va.
Steel Fabricator: Bristol Steel and Iron Works, Inc.

AWARD OF MERIT 1971 — LONG SPAN

Gulfgate Bridge
Port Arthur, Texas

Designer: Modjeski and Masters for the Corps of Engineers, Galveston District
Owner: Jefferson County
General Contractor: Coastal Construction Company
Steel Fabricator: Bethlehem Steel Corporation



AWARD OF MERIT 1971 — LONG SPAN

White River Bridge
Des Arc, Arkansas

Designer: Garver & Garver, Inc., Engineers
Owner: State of Arkansas
General Contractors: Superstructure: American Bridge Division, U. S. Steel
Substructure: W. L. Sharpe Contracting Co., Inc.
Steel Fabricator: American Bridge Div., U. S. Steel

AWARD OF MERIT 1971 — LONG SPAN

Willamette River (West Linn) Bridge
West Linn, Oregon

Designer: Moffatt, Nichol & Bonney, Inc.
Owner: State of Oregon
General Contractors: (A Joint Venture)
Willamette-Western Corp. and Donald M. Drake Company
Steel Fabricator: Isaacson Structural Steel Company

AWARD OF MERIT 1971 —
MEDIUM SPAN, HIGH CLEARANCE

Chulitna River Bridge
North of Anchorage, Alaska
Designer: Alaska Department of Highways
Owner: State of Alaska
General Contractor: (A Joint Venture)
A & G Construction Co. and M-K Construction Co.

AWARD OF MERIT 1971 —
MEDIUM SPAN, HIGH CLEARANCE

Irondequoit Bay Bridge
Monroe County, New York
Designer: New York State Department of Transportation
Owner: State of New York
General Contractors:
Superstructure: American Bridge Div., U. S. Steel
Substructure: Brookfield & Baylor
Steel Fabricator: American Bridge Div., U. S. Steel

AWARD OF MERIT 1971 — MEDIUM SPAN, LOW CLEARANCE

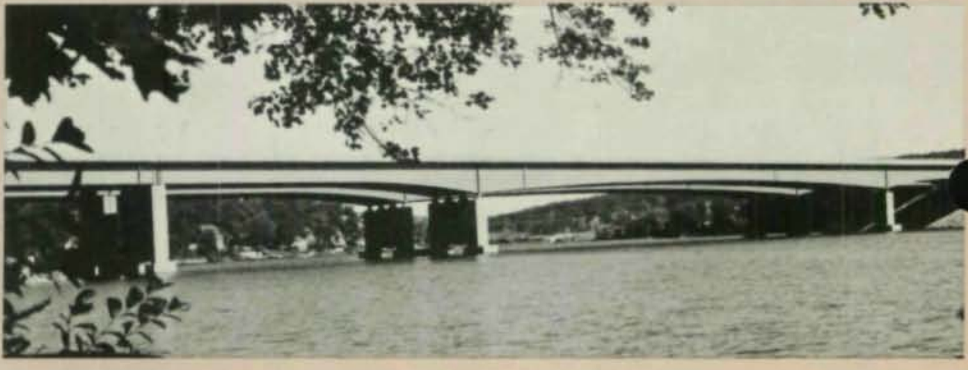
Amoskeag Memorial Bridge
Manchester, New Hampshire
Designer: Fay, Spofford & Thorndike, Inc.
Owner: City of Manchester
General Contractors: Superstructure: Curran-Lavoie, Inc.
Substructure: Cianbro Corporation
Steel Fabricator: Bancroft & Martin, Inc.

AWARD OF MERIT 1971 —
MEDIUM SPAN, LOW CLEARANCE

Oneida River & Bonstead Road Bridge
Onondaga & Oswego Counties, New York
Designer: King and Gavaris
Owner: State of New York
General Contractor: S. J. Groves & Sons Co., Inc.
Steel Fabricator: Ernst Steel Corporation

AWARD OF MERIT 1971 —
MEDIUM SPAN, LOW CLEARANCE

Shrewsbury-Worcester Bridge
I-290 over Lake Quinsigamond, Massachusetts
Designer: Singstad, Kehart, November & Hurka
Owner: The Commonwealth of Massachusetts
General Contractor: M. DeMatteo Construction Co.



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AWARD OF MERIT 1971 — SHORT SPAN

Cannonball River Bridge
South of New Leipzig, North Dakota

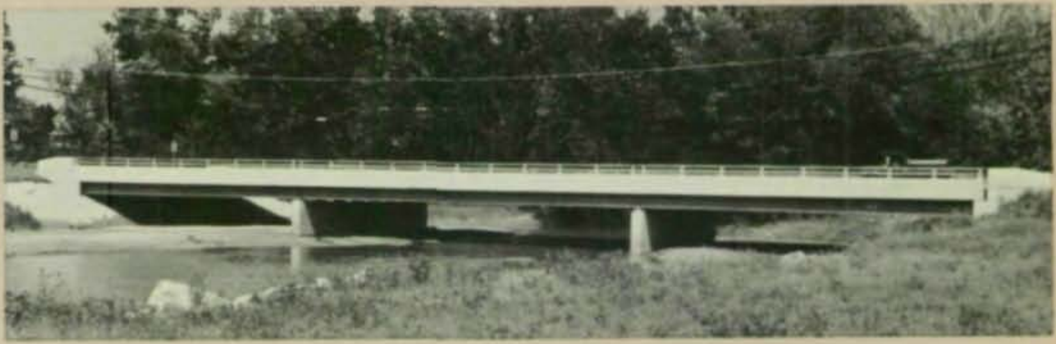
Designer: North Dakota Highway Department
Owner: State of North Dakota
General Contractor: James J. Igoe & Sons Construction, Inc.
Steel Fabricator: Hassenstein Steel Company

▶

AWARD OF MERIT 1971 — SHORT SPAN

U. S. Rte. 1 over Patuxent River
Laurel, Maryland

Designer: State Highway Administration
Owner: State of Maryland
General Contractor: John D. Sheetz Constr. Co.
Steel Fabricator: High Steel Structures



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AWARD OF MERIT 1971 — SHORT SPAN

Walnut-Farber Street Bridge
East Sparta, Ohio

Designer: Robert A. Kolopus, Stark County Bridge Engineer
Owner: Stark County
General Contractor: Escola Construction Company
Steel Fabricator: Gregory Fabricating Corporation

AWARD OF MERIT 1971 — HIGHWAY GRADE SEPARATION ▲

5 Undercrossing of Boeckman Road
ckamas County, Oregon

signer: Oregon Department of Transportation
Owner: State of Oregon
General Contractor: Guy F. Atkinson Company
Steel Fabricator: Isaacson Structural Steel Company, Division of Isaacson Corporation

AWARD OF MERIT 1971 — HIGHWAY GRADE SEPARATION

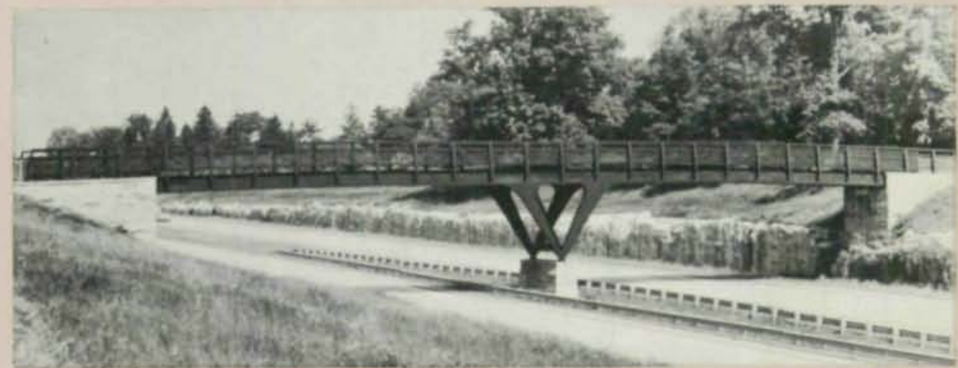
Bridge 16 — 28th & Dodge Interchange
Omaha, Nebraska

Designer: Kirkham, Michael & Associates
Owner: State of Nebraska
General Contractor: Hope Engineering Corporation
Steel Fabricator: Gate City Steel Corporation

AWARD OF MERIT 1971 — ELEVATED HIGHWAYS OR VIADUCTS

Homewood Interchange, Ramp A
Birmingham, Alabama

Designer: State of Alabama Highway Department
Owner: State of Alabama
General Contractors: Morris-Shea Bridge Company
Moss-Thornton Company, Inc.
Steel Fabricator: Gamble's, Inc.



AWARD OF MERIT 1971 — SPECIAL TYPE

Bridle Path Bridge Over I-64
Louisville, Kentucky

Designer: Vollmer Associates
Owner: Commonwealth of Kentucky
General Contractor: Greer Bros. & Young, Inc.
Steel Fabricator: Wise Iron Works, Inc.

AWARD OF MERIT 1971 — SPECIAL TYPE

Menomonee Falls Pedestrian Bridge
Menomonee Falls, Wisconsin

Designer: Wisconsin Division of Highways
Owner: State of Wisconsin
General Contractor: Tubesing Construction Company, Inc.
Steel Fabricator: Phoenix Steel Corporation