STEEL BRIDGES '84

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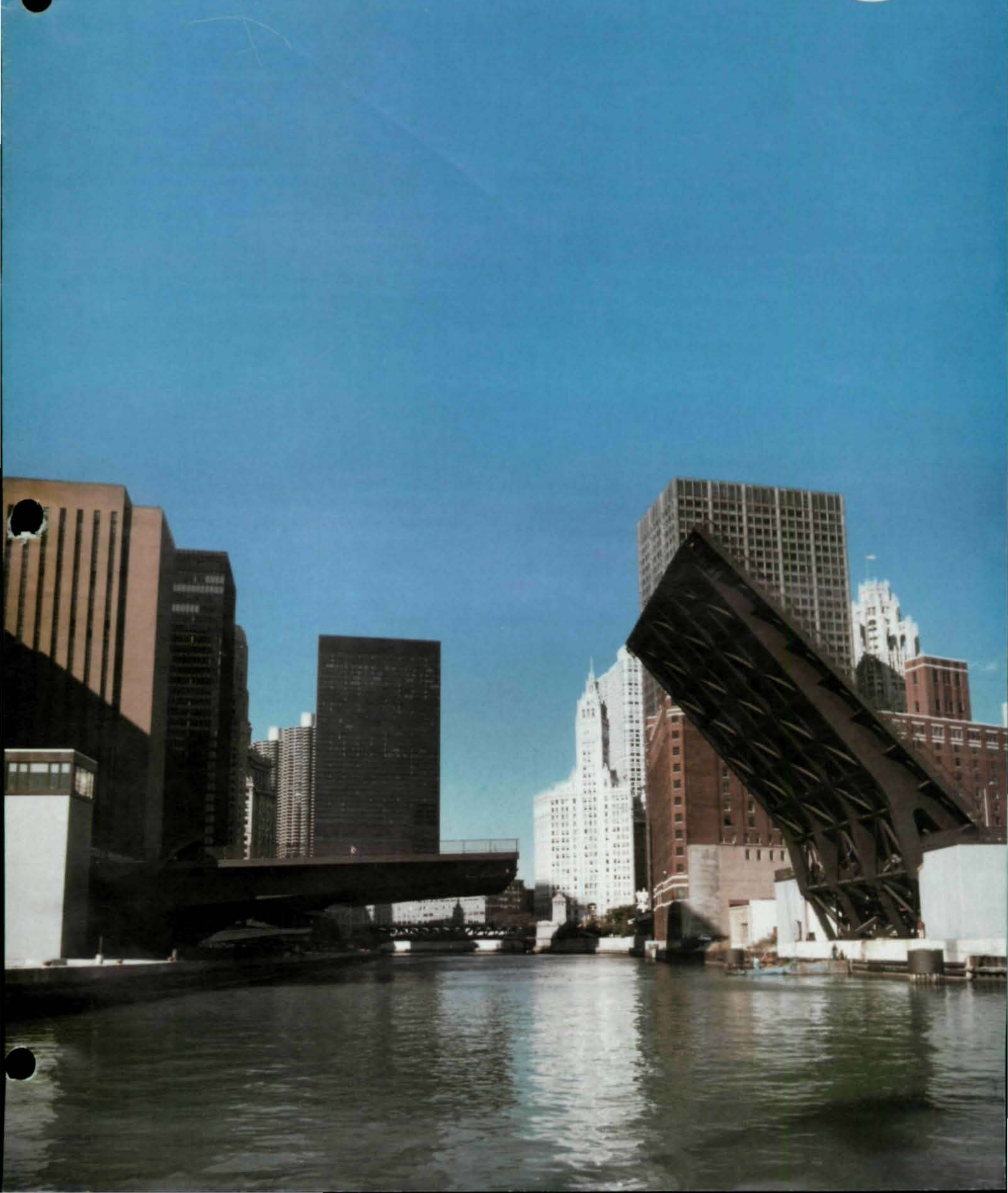


STEEL: Still Meeting the Test

The goal of the bridge design engineer is to design a structure that will serve best, last longest and cost least. Aesthetics may be a factor, especially if there is a requirement that a new structure be compatible with a companion bridge or a scenic landscape. Local residents sometimes lobby for a replacement bridge "like the old one". There is inevitably an attraction to the latest fashion in design.

Individual designers will have different opinions about material selection, often based on their own familiarity with design methods or their knowledge of problems with construction and maintenance. New materials and techniques are always considered to compare cost-effectiveness and/or construction time. Requirements of climate and terrain influence decisions.

Bridge design is dynamic, thriving on change. And the friction of competition provides the impetus for innovation: new methods and technology are developed, materials are improved. Although bridge engineers over the last century have logically and scientifically constructed monumental and efficient structures, the evolution of steel bridges continues. Today's technology makes the steel bridge capable of competing with other materials and systems over the entire range of spans.

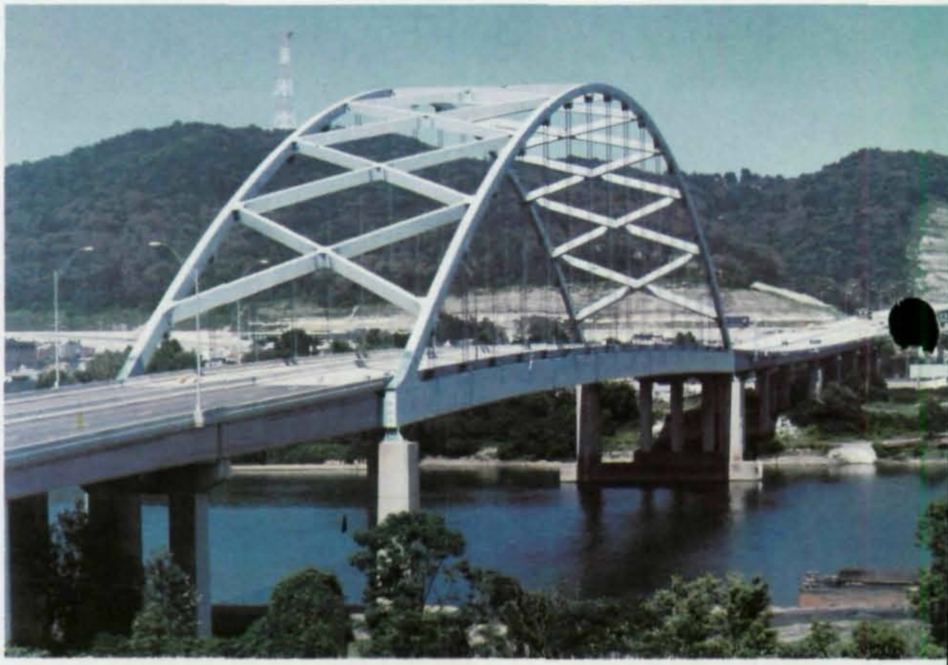
Advances in engineering knowledge have been correlated with improvements in material quality and fine-tuning of manufacturing processes by steel producers and with inventive methods of fabrication and erection.

Modern steel, often high-strength, with a combination of welded and bolted construction provides significant economies and reliability. New developments have resulted in lightweight structures that use less material with greater efficiency. However, designers have also learned that material savings cannot always be equated with a decrease in total cost, especially if accompanied by increased complexity of fabrication. Today's engineer should be aware of the trade-offs required in assessing the impact of individual factors.

For instance, while modern design codes for steel construction specify requirements for strength and stability of members and connections, the choice of detail is left to the discretion of the designer. An integrated approach to steel design has become a necessity. Computer techniques for analysis and design permit rapid analysis of alternates and refined design of components. The choice of details, connections and corrosion protection impact on the economics of fabrication and erection.

The evolution toward greater simplicity and the availability of better steels and construction methods has also resulted in more beautiful steel bridges. Today's truss bridges, containing smaller and fewer members, have the clean smooth lines that please the contemporary eye. One of the most attractive steel bridge forms that has evolved is the cable-stayed bridge, its silhouette as sharply etched as a sail on *the horizon.*

But the main driving force in this trend toward simplicity has not been aesthetic considerations. No matter how pleasant or elegant the design, it must also be conceived with economy in mind. For structural steel, economy means design that recognizes and exploits the best use of the material while taking advantage of fabrication procedures and techniques for optimizing manufacturing and erection costs. The result is not just a more economical bridge but also a more efficient and competitive steel structure.



The 1984 Prize Bridge winner in the long span category, this single-span tied arch bridge carries traffic *over the Ohio River south of Wheeling, West Virginia. A century of experience in building bridges with steel* is now "built in", promising structural integrity and displaying the evolution towards simplicity and economy.

Steel's Advantages

Steel bridges offer distinct advantages for all types of structures from simple short spans to major river crossings. In many situations, steel may prove to be the only logical choice.

Competitive Costs—Properly designed steel bridges can be cost competitive over virtually all span lengths.

Desirable Material Properties—Steel is a high-quality homogeneous material that provides high compressive and tensile strengths with little variability. It is almost perfectly elastic to its yield point and thereafter has a large amount of ductility that will (1) accommodate local stress raisers; (2) provide a large reserve strength; (3) accommodate imposed deformations such as those resulting from secondary bending; (4) absorb seismic loading; and (5) provide the greatest *strength-to-weight ratio of all major bridge* materials.

Long History of Bridge Applications—Steel has been used in bridge construction in the United States for over a hundred years. In contrast, prestressed concrete bridges have been used in the United States for only about 30 years, and the larger segmental precast concrete bridges for less than a decade. The reliability of steel has been proven on thousands of structures.

Speed of Construction—Normally, steel bridges can be built faster than concrete. Off-site fabrication under controlled conditions encourages efficiency. The ease with which light steel members can be erected over land and water in summer or winter helps to minimize the construction time. The predictable behavior of steel, combined with its great tensile strength and high strength-to-weight ratios reduces the prospects for problems during construction.

Quality of Construction—Fabrication and erection procedures for steel bridges are highly developed and many skilled practitioners are available. High quality workmanship and uniformity within narrow tolerances can be achieved.

Ease of Repair—Steel bridges can generally be repaired quickly and easily. Decks, for example, can be replaced without shoring.

Low Superstructure Weights—Steel superstructures are usually lighter than comparable concrete superstructures. This, of course, reduces substructure costs and is especially important where seismic factors are a consideration or soil conditions are poor.

Shallow Superstructure Depths—Steel superstructures can usually be designed with shallower depths than concrete structures for sites where clearances are limited.

The Eads Bridge, St. Louis, Mo., was dedicated on July 4, 1874, and has been in use ever since. The poet Walt Whitman called it: "A structure of perfection and beauty unsurpassable." The Eads is the first bridge constructed with steel as the primary metal and is a three-span ribbed arch.

The Simpler, the Better

To minimize cost, steel bridge details must be kept simple. The structural behavior of simple details is also easier to understand and analyze.

Because a major part of the cost of a bridge is usually construction (fabrication, shipping, erection), minimum bridge costs require modern, efficient construction practices. While relative costs for various specific fabrication and erection options will vary among different contractors, there are some principles that generally result in cost savings.

Duplication usually reduces fabrication costs: the more elements that are the same, the less expensive the fabrication. Duplicating flange sizes, web sizes, stiffeners, diaphragms and bracing within a single bridge or within a multi-bridge job generally results in substantial savings. Permitting alternatives, especially in making field connections, can reduce costs because different fabricators and erectors may prefer different options.

Fracture-critical members will generally cost more to fabricate than non-fracture critical members. Therefore, it is often cost-effective to minimize the number of members that must be classified as fracture critical.

The most economical member length and weight to fabricate, ship and erect may vary dramatically between various fabricators, erectors and contractors. Design should be prepared showing optional field splices to take full advantage of the various capacities of each fabricator/erector/contractor team.

What Else Is New?

As the cost advantages of new concepts become more widely accepted, contractors will develop even more innovative construction procedures for further cost savings.

Research is continuing by steel producers, fabricators and government agencies, all working to improve the performance and economy of steel bridges.

The Federal Highway Administration has led the way to lower cost structures by permitting cost-saving alternatives to the traditional bidding process. These include alternate designs, value engineering and contractor options. As a result, designers, contractors, fabricators, erectors and producing mills are forming design-build teams to offer competitive designs as alternatives to those prepared by state DOTs.

Load Factor Design (LFD) and Autostress Design are leading the way to realistic designs, accurately reflecting the conditions that actually occur in steel bridges. The result is more efficient use of materials and lower costs.

Some states have developed standard designs for short span bridges in both steel and concrete. But not all are clones: some will allow consultants and contractors to change the superstructure so that the most appropriate and economical spans are designed and built. Contractors are given the option of requesting an alternate design if they can prove it would be more cost-effective.

Structural rehabilitation, virtually a new field, is requiring innovative ideas that are often unique to a particular structure. Designs for hybrid structures, sometimes unsolicited, are being offered for reconstruction of existing bridges. Modifications are intended to widen, strengthen, add lanes, reduce stress. Such designs may marry an arch to a truss or provide a simple facelift for an aging grande dame.

Research methods have also improved and are increasingly implemented to solve, and even anticipate, problems:

- Wind tunnel testing allows design for gales of hurricane velocity.
- New corrosion protection methods are being researched and tested.
- Programs are being devised for increasingly sophisticated bridge testing plans, as well as methods of determining both risk potential and total or remaining bridge life.

No Easy Payment Plan

As the current assessment of the requirements of the infrastructure continues and needs are defined, more money will be spent and new financing methods will be developed to stretch road and bridge dollars. Taxes may be increased in some states, "infrastructure banks" are being considered in others. Small communities are often implementing "home grown" solutions to pressing problems.

Although wornout or poorly maintained structures are often blamed for the current crisis, more than half of all bridges eligible for federal aid are deficient because of "deck geometry"—the bridge is narrower than the highway it serves.

With a century of steel bridges standing as evidence of strength, stability and service, the steel industry has met the test of time, but is not content to rest on such trustworthy laurels. Its motto for the decades of change ahead is: "Steel spans the future."

Winning Alternatives: Steel Steals the Day

The Federal Highway Administration's (FHWA) design policy for bridges requires that when cost estimates of preliminary designs are close, both should be completed and bid in competition. The FHWA is encouraging states to build the most cost-effective structures and to use value engineering at the design stage.

In some states, cost-saving modifications of the traditional bidding process are being used. The practice is sometimes referred to as modified turnkey, design-construction or contractor-designed alternates.

Federal and most state regulations require that the states have plans and specifications before calling for bids. However, the precise wording of regulations is often vague enough to permit states to let jobs with "schematic plans" listing the specifications designs must meet.

The practice varies widely in its application, but is usually applied on larger jobs. The steel industry has been active in this practice and helps prepare design data for competitive designs, especially in those instances where the original steel designs were prepared by state DOT's several years ago and do not reflect recent innovations in steel bridge design.

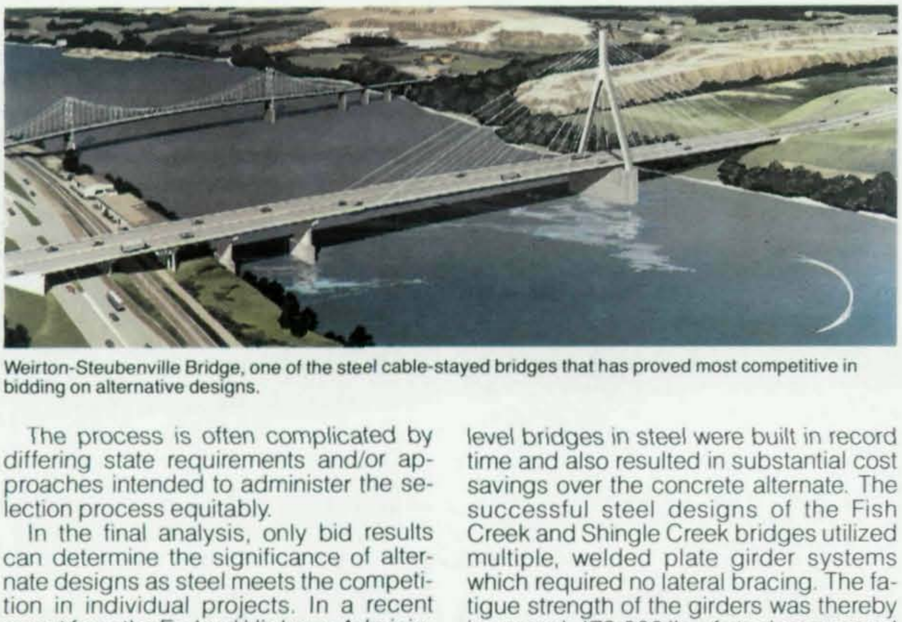
Steel Successes

At Keokuk, Iowa, a 3,340-ft continous welded plate girder bridge will span the Mississippi. The steel design proved a heavy favorite over segmental concrete box girder alternates. Of 11 bids submitted, nine were based on steel and two on concrete. The successful steel bid beat the lowest concrete bid by almost 11 percent. The 64-ft wide bridge will parallel a nearby existing steel truss crossing and will carry U.S. Route 136 traffic on 15 spans, ranging from 149 ft to 295 ft long.

Steel plate girders were also selected over a contractor's alternate segmental concrete box design for the 1,555-ft bridge carrying I-395 over the Penobscot River near Bangor, Maine.

Thirteen contractors unanimously chose to bid the steel option for 7,500 ft of dual approaches for a tied-arch bridge carrying U.S. Route 51 over the Illinois River near LaSalle, Ill. The successful bid for the welded steel plate girder alternative was $33.2 million—about $6.6 million below the Illinois DOT's estimate. No bids were submitted on the post-tensioned concrete box girder design.

In Southern Utah, a pair of twin high-level bridges in steel were built in record time and also resulted in substantial cost savings over the concrete alternate. The successful steel designs of the Fish Creek and Shingle Creek bridges utilized multiple, welded plate girder systems which required no lateral bracing. The fatigue strength of the girders was thereby improved, 173,000 lb. of steel were saved and costs of fabrication, handling and erection were reduced.



Weirton-Steubenville Bridge, one of the steel cable-stayed bridges that has proved most competitive in bidding on alternative designs.

The process is often complicated by differing state requirements and/or approaches intended to administer the selection process equitably.

In the final analysis, only bid results can determine the significance of alternate designs as steel meets the competition in individual projects. In a recent report from the Federal Highway Administration listing bid results on 39 projects designed with alternates since March, 1979, steel was successful on more than 50 percent of the projects. The FHWA estimates that the requirement for steel alternatives has saved the taxpayers millions of dollars.

Maximum efficiency is achieved by bridge engineers familiar with the most up-to-date design techniques, and teams comprised of producing mills, designers, contractors, erectors and fabricators can often combine forces to shave costs and streamline solutions.

Steel plate girders were also chosen for the 17 spans of the West Kansas Avenue bridge over the Kansas River, Kansas City, Kan. There were no bids on a concrete segmental box girder alternate. The bridge, 2,880-ft in length, will use approximately 3,000 tons of steel and will be built in four structural units.

There was only one concrete bid on alternate designs for the State Route 1 bridge over the Tennessee River, Benton-Humphreys Counties in Tennessee. But the successful steel bidder was more than $3 million below the bid for segmental concrete. The steel choice, designed by Tennessee DOT utilizing Load Factor Design (LFD), will be built of I-shaped plate girders and is 2,207-ft in length. There are eight spans, the longest 411 ft and the shortest 154 ft. Approximately 5,100 tons of A572 and A588 steel, painted, will go into the completed structure. Of interest is the fact that the single concrete bidder also chose to make a (lower) steel bid.

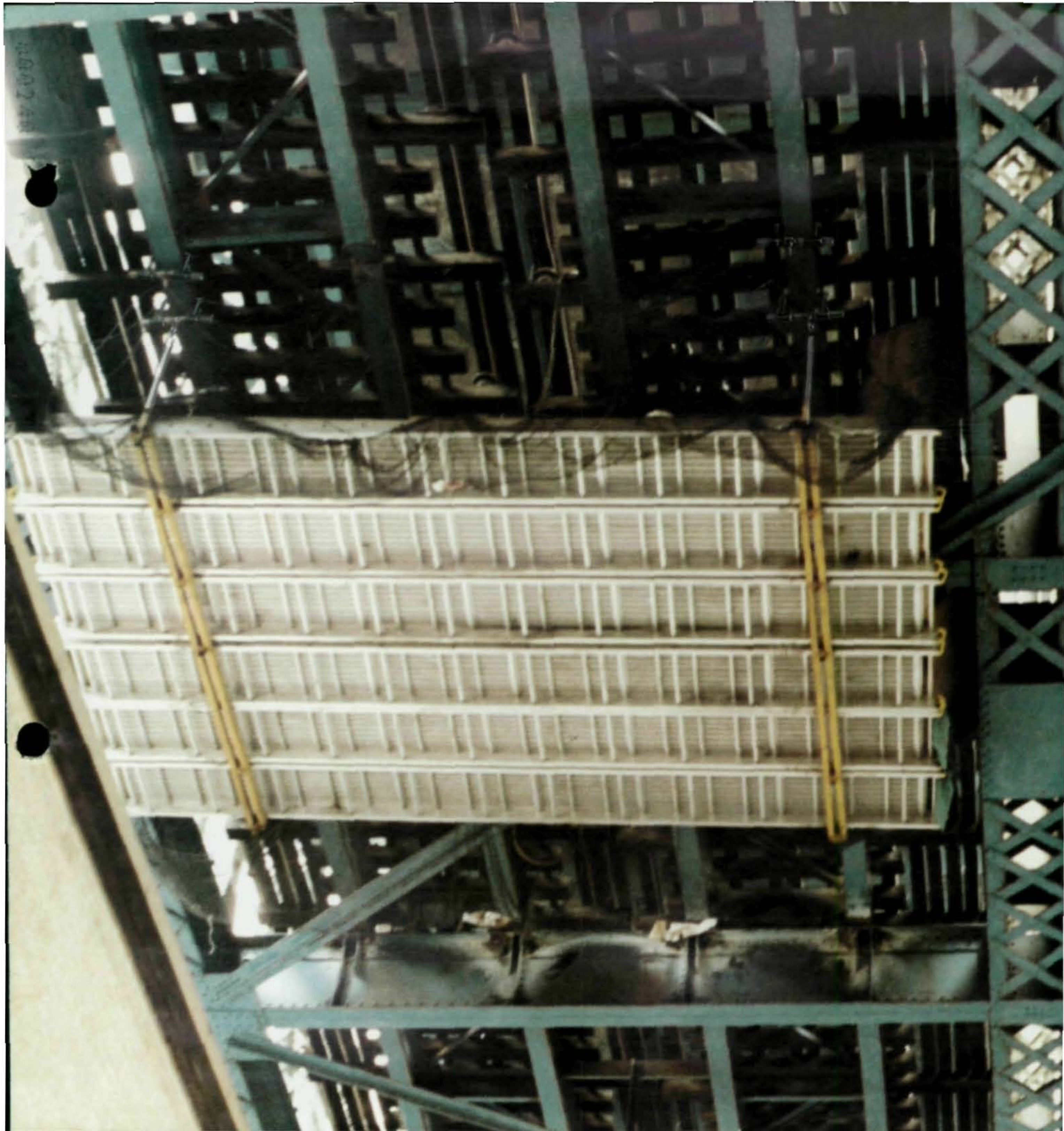
Fifteen bidders competed for a bridge over the Cumberland River at Dover, Tennessee. Again, steel plate girders were successful in competition with the segmental concrete alternate. Twelve of the bidders chose to bid on steel; two on concrete and one submitted a redesigned steel structure. The winning steel bid was for $8.7 million, nearly $2 million less than the concrete proposal. The three-span structure is designed with girders on 20'8" centers, with one sub-stringer per bay, utilizing current guidelines for economical plate girder bridges.

In Broward County, Florida, three bridges will be built parallel, carrying SR862 (I-595) traffic. Bid early this summer, the low steel bid was $28,584,208, compared to the lowest concrete bid, $28,848,397. The three structures, painted hybrid plate girders, will each be approximately 1,950 ft in length and will contain 9,300 tons of steel. The girders are typically 84" deep, except for main spans where girders are haunched to 177" deep.

Construction is already underway on the I-579 Crosstown Boulevard Bridge in Allegheny County (Pittsburgh), Pa. A segmental cast-in-place box girder concrete design was unsuccessful in bidding. The structure is being built of steel plate girders for approximately $16 million. The bridge is 142'6" wide and has three spans: 305-440-305-ft. It will contain 5,235 tons of steel and is expected to completed in late 1985.

The state-of-the-art cable-stayed bridges, framed in steel, are giving strong indications of becoming a leading contender for long-span bridge solutions.

A cable-stressed bridge weighing one-fifth less than a conventional steel plate girder structure was selected for the Bonners Ferry Bridge over the Kootenai River on U.S. 95 near the Canadian border. The concrete alternate was a cast-in-place, post-tensioned bridge. All eight bidders for the 1,378-ft-long four-lane bridge chose the cable-stressed steel alternative. The Idaho's DOT's estimate for the bridge was $11.5 million. The low steel bid was $9.14 million. The steel design saved the taxpayers $2.36 million. And according to the designer, while the concrete design would have required two seasons for construction, the steel cable-stressed bridge could be built in one.



Cable-Stayed Steel Bridges: Latest Trend for Long Spans

The first modern cable-stayed bridge was built in 1955 in Stromsund, Sweden. Designed and fabricated in Germany, the bridge utilized steel plate girders and cross beams supporting a reinforced concrete deck.

During the next decade, several cable-stayed bridges were built in Germany. All had orthotropic steel decks forming an integral part of the longitudinal plate or box girders. Providing several advantages over competing types of long span bridges, the cable-stayed concept has now spread throughout the world.

Recently, a slightly modified type of cable-stayed bridge has been developed and proved to be most economical in the United States and Canada. It utilizes a steel plate girder with a composite concrete deck instead of a steel box or plate girder with an orthotropic steel deck. Although a composite design weighs more than a comparable orthotropic design, it is considerably less expensive to fabricate and, consequently, provides a cost-effective alternative.

Since the fall of 1983, three cable-stayed bridges of this type have won in competitive bidding against all-concrete cable-stayed bridges: the Quincy Bridge, Illinois; the Weirton-Steubenville Bridge, West Virginia; the Annacis Bridge, British Columbia.

All three winning bridges utilized a wide-spacing two-girder system, simple details and composition action.

Luling-Destrehan Bridge, recently completed.

Luling-Destrehan Bridge

The Luling-Destrehan Bridge is the first high-level long-span cable-stayed bridge built in the United States. Total length of the structure, including approaches, is 11,080 ft. The central segment of the crossing consists of a 5-span cable-stayed orthotropic bridge with a central span of 1,222 ft. The longest span of its kind under traffic in the U.S., it is also the second longest cable-stayed span in operation in the world.

Built to resist hurricane winds, the bridge has been instrumented to check actual behavior against wind tunnel results performed on models. Weathering steel throughout will require a minimum of maintenance. The 27,790 tons of weathering steel in the Luling Bridge set a record for tonnage in an individual bridge.

Most features in the central span are unique, including the use of standard trapezoidal ribs in orthotropic steel decks. Twin 14-ft-deep steel box girders are used in the five continuous spans.

Weirton-Steubenville Bridge

The Weirton-Steubenville Bridge is an asymmetrical cable-stayed bridge over the Ohio River with a main span of 820 ft and a back span of 688 ft. These two spans are supported by cable radiating from a single 360-ft high (above the deck) tower. Including four approach spans, the total length of the bridge is 1,964 ft.

Two steel edge girders support a system of steel floor beams and stringers that, in turn, support a poured-in-place composite concrete deck. Cables are anchored to the deck system at 60-ft intervals, and the floor beams are spaced at 20-ft intervals.

The edge girder webs are sloped to conform to the plane of the cables. The cables are anchored to a weldment attached to the exterior of the edge girder web through a system of gusset and stiffener plates.

Annacis Bridge

The Annacis Bridge, Vancouver, British Columbia, is currently under construction. It will have a record-breaking main span length of 1,526 ft and a total length of 3,051 ft for its five spans. The two 6½-ft-deep edge girders are supported by cables at 30-ft intervals. Floor beams are spaced at 15-ft intervals. Weathering steel is used for the girders and beams. The deck structure will be erected in 30-ft units starting at the towers and moving outward in both directions to balance the cable forces.

A total of 192 cable stays fan out from the two 500-ft high (390 ft above deck) concrete towers.

Quincy Bridge

The Quincy Bridge, crossing the Mississippi River near Quincy, Ill., has a 900-ft center span, two 440-ft side spans and two 200-ft transition spans. The center and side spans are supported by cables radiating from two 182-ft-high (above deck) concrete towers. Cable-supported edge girders, 72 in. deep, carry 36-in.-wide flange floor beams. Rolled beam stringers are continuous over the floor beams and support the precast post-tensioned deck slab units. The edge girders, stringers, and deck act together to carry the longitudinal load from the cables.

Future Plans

It is apparent that steel cable-stayed bridges are probable choices in a number of structures now under consideration, and have already proven successful in several recent bridge awards. Two alternate cable-stayed designs are being developed for a twin-span structure over the James River on Interstate 295 near Richmond, Virginia. With 145 ft of vertical clearance for ships using the city's Deepwater Terminal, cost estimates are now at about $62 million.

Japanese engineers regard spans of up to 2,300 ft "technically feasible". Initial planning for a bridge over part of Yokohama Bay with a central span of 1,509 ft is already underway.

One of the five options being studied for a new $85-million structure to replace the Cochrane Bridge over the Mobile River in Mobile, Ala., is a cable-stayed steel girder bridge with a reinforced concrete deck and pylons.

Work is progressing toward final design of a 3-mile crossing of the Knik Arm at Anchorage, Alaska. Predesign work suggests either a 500-ft-span double-deck four-lane truss or a stayed-girder bridge with a 1,200-ft main span and 150 ft of clearance above mean high water. Design constraints include severe site conditions, high tides, and 8-knot current and winter ice floes.

Steel has, of course, proven an excellent material for cable-stayed bridges. Fabrication is generally conventional and the size of members is duplicated frequently. Simplicity of details enable many fabricators to bid effectively. Since members are relatively small: 5, 6, 7-ft deep, it is not necessary that they be shipped by water. Therefore, most bridge fabricators can manufacture and ship the components by truck or rail, thus increasing competition and lowering price.

Trusses Are Still Terrific

Truss bridges have dominated river crossing construction in North America for nearly a century. Economical and efficient, they offered the strength and durability especially vital to railroad bridges. Many 75-year-old truss bridges are still carrying traffic and with proper maintenance will remain in service for years to come.

When technological advances permitted designers to utilize the deep plate girders, box girders and cable-stayed systems, truss bridges lost the spotlight for a few years. Once called "cathedrals of steel" inaugurating and commemorating the industrial age, some designers considered them lacking in aesthetics and expensive to maintain.

But the inherent advantages of truss bridges cannot be ignored and the design is still a terrific contender for spans from 500 to 1,500 ft. For the budget-conscious who believe the bottom line, cost, is the deciding factor, the truss may be the most economical steel bridge of all for that span range. And new concepts, design techniques and materials are tipping the scales even further in its favor.

Introduction of the Load Factor Design (LFD), when applied to truss bridges, reduces the weight of steel required and makes the truss bridge even more economical. Fabricators have reduced manufacturing cost of members through computerized and numerically controlled drilling equipment. Three-plate weldment sections are now used to cut maintenance expenses (easier to paint) and with closed box section designs the member is sealed and interior painting is eliminated entirely. With A588 weathering steel, box members are left unpainted. Again, no maintenance painting is required.

Essentially, a truss is a rigid structural member with steel components arranged in triangular panels. Each panel shares part of the bridge load. Its primary advantage is its capability for spanning long distances and carrying heavy loads efficiently and economically.

In a through pass, greater underclearance can be provided than in other types of bridge. And years later, it can be reinforced economically to take heavier loads.

Greater New Orleans Bridge

The second Greater New Orleans Bridge crosses over the Mississippi River adjacent to a similar 3-span cantilever truss highway bridge opened to traffic in 1958. The new bridge has approximately the same configuration as the first, but is 102 ft wide compared with 65 ft for the old bridge. The new bridge also has a higher kingpost, or humpbacked, truss.

The two New Orleans bridges have the longest cantilevers in the U.S. and are the same length with similar profiles. Each three-span truss is 3,019 ft long and features a 1,575-ft center span. The center spans consists of a 689-ft-long suspended span supported on two 443-ft-long cantilevered arms.

The low bid was $18 million less than the designer's original estimate. LFD reduced steel requirements by 3,000 tons and the option to allow fabrication of box members reduced costs by $4 million, according to the designer, Modjeski & Masters. Bolting in lieu of welding eliminated the higher fabrication costs of fracture-critical members. The steel erector, John F. Beasley Construction, used innovative procedures that further cut costs: pulling the two cantilever arms together using special scissor-type jacks as well as a new, less expensive method of installing the eyebars that act as chords for the kingpost truss.

Sewickley Bridge

The Sewickley Bridge over the Ohio River near Pittsburgh, a 1982 AISC Prize Bridge Award winner, illustrates several of the advantages of truss bridges.

Designed by Richardson, Gordon Associates to replace a 70-year-old truss bridge, the system was chosen from among three alternatives for both speed and cost. Only 520 days were needed for the construction, including demolition of the old structure.

The structure is a three-span continuous Warren truss with spans of 375 ft-750 ft-375 ft. Design features to increase life of the new bridge and decease maintenance were epoxy-coated deck reinforcing bars, a complete deck drainage system, sealed deck expansion joints, and a high performance paint system. Sealed box truss members and simple details were used to provide an attractive, low maintenance structure. The new structure is similar in configuration to the replaced bridge, satisfying the wishes of local residents.

Use of weathering steel (A588) for bridges continues to increase and the newer truss bridges are no exception. The world's longest trussed arch bridge over the New River in West Virginia is of weathering steel. So is the recently completed second Newburgh-Beacon truss bridge in New York. The reconstructed Augustine Bridge near Wilmington, DE utilized a continuous, unpainted A588 steel deck truss superstructure which not only resembled the original wrought iron bridge but could also be supported on the existing stone piers.

Trusses have been around for such a long time that, like old friends, we sometimes take them for granted. But, for the record, trusses are *still* terrific.

Steel beats segmental concrete in Maine's contractor alternate design bid competition.

Credits:

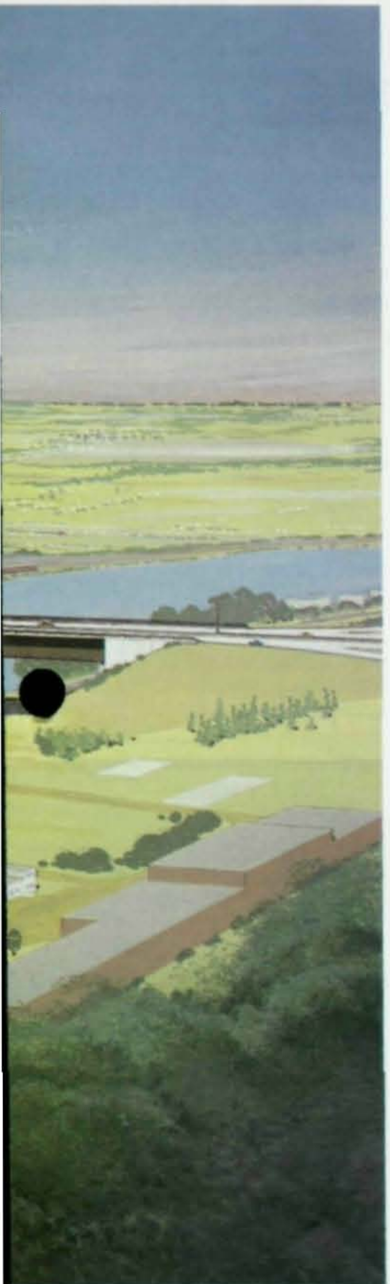
Owner/Structural Engineer: Maine Department of Transportation, Augusta, Me.

Fabricator: High Steel Structures, Inc., Lancaster, Pa.

General Contractor: Cianbro Corporation, Pittsfield, Me.

Bridge Facts: Bangor-Brewer Bridge, Bangor, Maine

Design Method: Load Factor Design
Design Loading: HS25 and Alternate Military
Total Length: 1,550 ft
Steel Grade: ASTM A588 weathering steel
Steel Supplier: Bethlehem is furnishing all of the structural steel for the project.
Expected Completion: Fall of 1986



Maine DOT design supports Bethlehem's Bridge Girder Optimization Program guidelines: (1) Load Factor Design, (2) unpainted weathering steel and (3) wide girder spacing

Parallel-flange steel plate girders were found to be the most cost effective design for this six-lane bridge over the Penobscot River between the cities of Bangor and Brewer, Me.

Maine DOT provided steel and concrete design alternates. The design options included a steel girder bridge with a concrete slab, a segmental concrete box girder, or the contractor's own design for the 1,550-ft-long project.

The low bid of $13,882,785 for the contractor's alternate design segmental concrete structure was rejected. Reportedly, it did not satisfy all of Maine DOT's criteria. As a result, the contract for the State's steel girder design was awarded to Cianbro Corporation for its bid of $13,939,107.

The reasons for steel's success

The State considered several steel design variations including haunched girders, box girders, and varying span lengths and girder spacings. However, the parallel-flange steel plate girder design was found to be the most economical overall. The winning steel design, developed by the State, is an eight-span continuous unit having spans of 117-120-200-300-248-200-200-170 ft.

Three key factors contributed to the economy of the steel design:

1. *Load Factor Design*—The State's bridge engineers estimate that the use of LFD will result in material cost savings of about 10% over Working Stress Design. With LFD, a lower factor of safety is applied to dead loads than to live loads because dead loads are more predictable. The ratio of dead load to total load increases with span length. Therefore, as span lengths increase savings due to LFD increase.

2. *Minimizing the number of girders*—Fewer girders in a cross section result in significant material, fabrication and erection cost savings. In addition to the savings in girders, fewer diaphragms and bearings are required. The Bangor-Brewer bridge uses eight lines of girders spaced at 14 ft and flared to 21 ft.

3. *Unpainted ASTM A588 Weathering Steel*—The most cost-effective steel grade is unpainted ASTM 588 weathering steel. A588 is specified for the entire superstructure of the bridge. A weathering steel bridge is more cost-effective on a first-cost basis than a painted steel design—without even considering future maintenance savings.

Bethlehem technical services

Our Construction Marketing Division can provide you with project assistance from the initial phase through completion of the bridge design. We've conducted literally thousands of bridge girder optimization studies over the years. And this wealth of experience can be put to work for you.

For more information about our bridge construction products or technical services, get in touch with Bethlehem's Construction Marketing Engineer through the Bethlehem sales office nearest you. Bethlehem Steel Corporation, Bethlehem, PA 18016.

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Guidelines For Economical Welded Plate Girder Bridges

SPECIAL ADVERTISING SECTION

Plate girder bridges first became popular in the 1930's. They were used in spans between the economic limits for rolled-beam and truss bridges. The upper limits of applicability for plate girders have gradually been extended.

Originally, the plate girder components were joined by riveting. In the early 1950's welding and high-strength bolting began to be used in bridge fabrication and by the mid-1960's most plate-girder bridges were fabricated by shop welding and utilized high-strength bolts for field splices.

Changes in highway configurations and the development of improved analytical methods provided more opportunities to use continuous, rather than simple, spans. Today, composite welded plate girders are the most common type of steel bridge and are generally competitive with other materials in the 100 to 450-ft span range. The upper limits of this range can be extended by adding cable stressing or by providing cable stays.

Recent advances provide further significant reductions in cost and can make plate girders competitive over a wide range of span lengths. Hundreds of industry studies over the years have made it possible to formulate some general guidelines which, if applied by the design office, lead to economical steel plate girder bridges. They include:

- Load factor design (LFD) is more economical than working stress design (WSD).
- Unpainted A588 weathering steel is the most economical material choice.
- The most economical painted design uses hybrid or homogenous 50 ksi material.
- Designs should use the least number of girders compatible with deck design.
- Transverse stiffeners should be placed on only one side of the web.
- Web depth can be varied without serious cost penalty.
- The optimum girder will often have a "nominally stiffened" web, usually $^1/_{16}$-in thinner than an unstiffened web. Web thickness within field sections should be kept constant.
- Girders should have web thickness between field splices.
- Longitudinally stiffened designs should not be considered for spans less than 300 ft.
- The number of flange splices should be minimized. Approximately 700 lb. of flange material should be saved to justify the introduction of a flange splice.
- Flange width within field sections should be kept constant.
- Haunched girder designs should not be considered for most conventional cross sections unless span exceeds 400 ft.
- Bottom lateral bracing should be omitted where allowed by AASHTO.
- Manufactured bearings such as elastomeric or pot bearings should be used.
- Use of composite action in negative moment regions should be considered.

Experience indicates that the most influential of these guidelines are the use of Load Factor Design, unpainted weathering steel and a minimum number of girders in the cross section.

New Steel Bridge Book Available Soon

The American Institute of Steel Construction announces publication of a new booklet on recent developments in steel bridge construction. Produced and developed by AISC, the booklet was written by special consultant Charles Schilling.

Particular attention is given to recent advances in steel bridge design for plate girder and rolled beam bridges, box girder bridges, cable-stressed bridges, cable-stayed bridges, and truss bridges. Extensive case histories on individual structures recently completed or now under construction are included: the Greater New Orleans, Annacis, Luling-Destrehan, Weirton-Steubenville, Whitechuck and many others.

There are sections on design and rating methods and a comprehensive list of reference materials suggesting further reading. Photographs and technical illustrations augment the commentary.

The new steel bridge book will be available in January 1985. For your free copy, write William Noble, AISC Marketing Department, 400 N. Michigan Avenue, Chicago, IL 60611.

Quality Certified Plants Can Handle Construction Demands

The American Institute of Steel Construction's Quality Certification Program, an inspection program conducted by an independent agency, encompasses the major functions of a steel fabricating plant: management, engineering and drafting, shop operations and quality control.

Certification under the program assures the construction industry that a certified structural steel fabricating plant has the capability to produce fabricated steel of a specific quality level for a given category of structural steelwork.

Plants are classified in three categories: Category I Conventional Steel Structures (which includes simple rolled beam bridges), Category II Complex Steel Building Structures, or Category III Major Steel Bridges. Certification in Category II includes Category I, and certification in III includes I and II.

The eighty plants currently certified in Category III (Major Bridges) have an aggregate capacity in excess of 1,200,000 tons of fabricated structural steel annually, more than double the amount of bridge work anticipated in 1985. Located in thirty states and situated in close proximity to all new construction, these eighty plants assure sufficient industry capacity to meet current demand. An additional seventy plants are certified in Categories I and II, providing additional capacity to fabricate structural steel for components and smaller bridges.

AISC's Quality Certification Program is open to all structural steel fabricators. Membership in AISC is not a requirement for participation. For further information on the program and a list of certified plants, write to: Quality Certification Administrator, AISC, 400 N. Michigan Ave., Chicago, IL 60611.

1985 International Symposium To Present Bridge Programs

The 1985 International Symposium on Structural Steel, scheduled for May 22-24 at the Palmer House in Chicago, will include programs dealing specifically with steel bridges. One of Japan's leading structural engineering professors will discuss cable-stayed steel bridges. Dr. Geerhard Haaijer, AISC Director of Research and Engineering, will lead a session on Short-Span Steel Bridges. Dr. John W. Fisher of Lehigh University will highlight techniques in retrofitting.

The agenda for the Symposium, cosponsored by the AISC and the Canadian Institute of Steel Construction, includes representatives from eight countries. Information and reservation forms are available from AISC, 400 N. Michigan, Chicago, IL 60611.

Steel's *Flexibility* Saves Dollars

Let's look at the ways:

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- Basic steel framing can be economically integrated with other construction products to solve special design requirements.
- Steel is especially applicable and offers numerous economical design approaches for retrofit and rehab projects. Steel can be easily modified, expanded or converted to suit future needs of owners or tenants.
- Flexible and/or alternate methods of erection on lower cost foundations provide speed in construction and offer significant savings in supervision and overhead costs.
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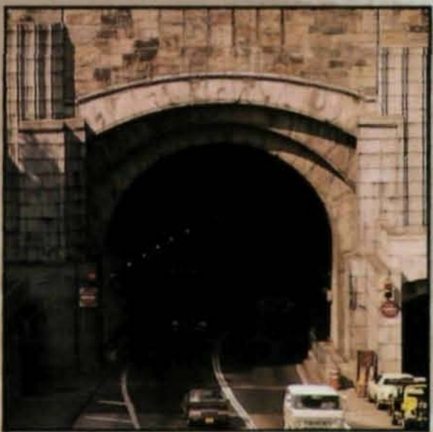

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Many applications of Du Pont Neoprene are decades old and still perform to expectations. That's just one reason why this durable rubber continues to be widely specified for many of today's most demanding engineering and architectural applications. The new bearing pads of the Manhattan Bridge and window gaskets of the Trump Tower are just two of many recent projects.

The durability of Neoprene explains why it is specified for uses as diverse and demanding as waterproofing membranes, highway seals and construction adhesives. It resists extreme temperature and weather, oil, chemicals and corrosive environments. Its mechanical properties withstand heavy loads, vibration and shock.

Dial Du Pont first

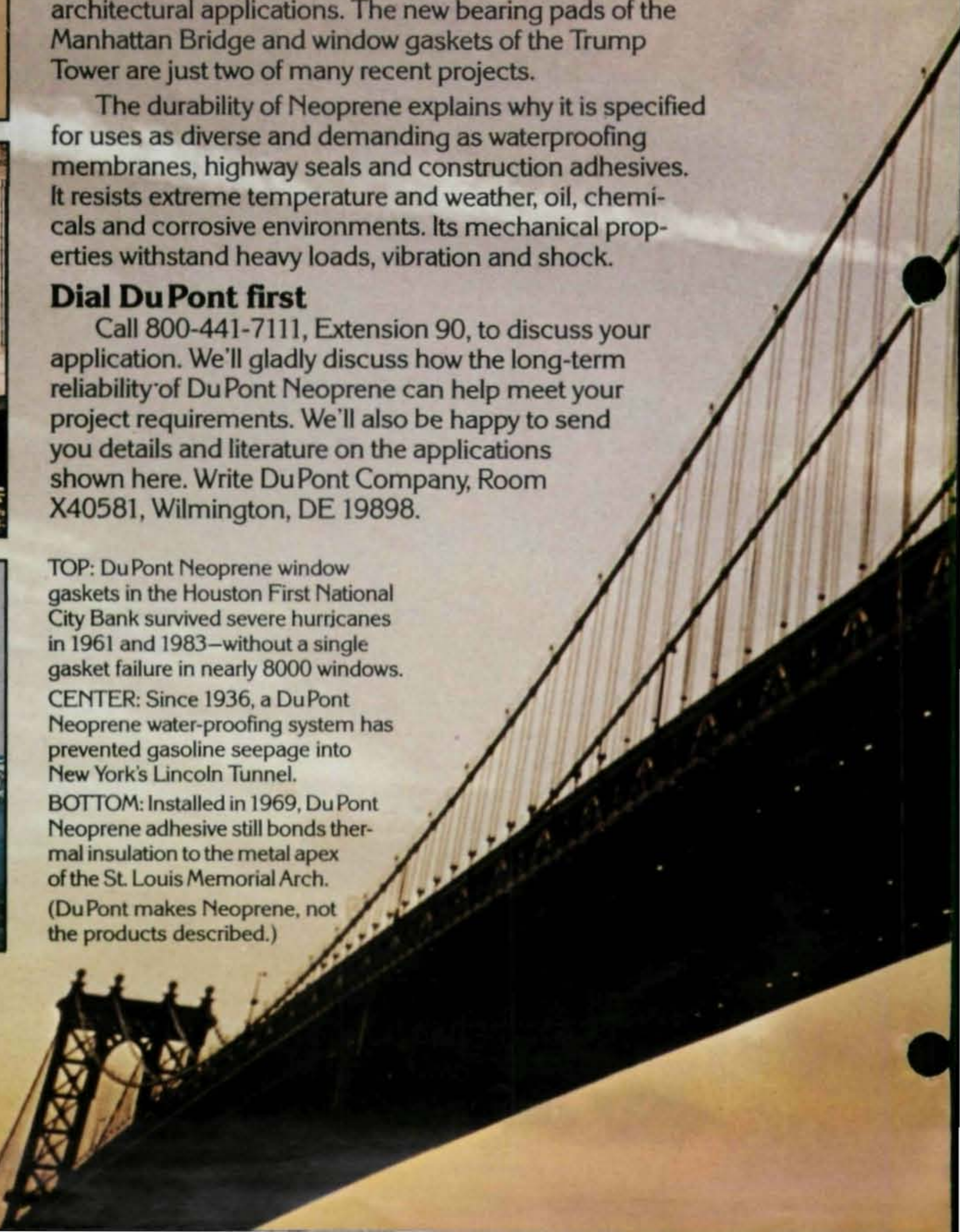
Call 800-441-7111, Extension 90, to discuss your application. We'll gladly discuss how the long-term reliability of Du Pont Neoprene can help meet your project requirements. We'll also be happy to send you details and literature on the applications shown here. Write Du Pont Company, Room X40581, Wilmington, DE 19898.

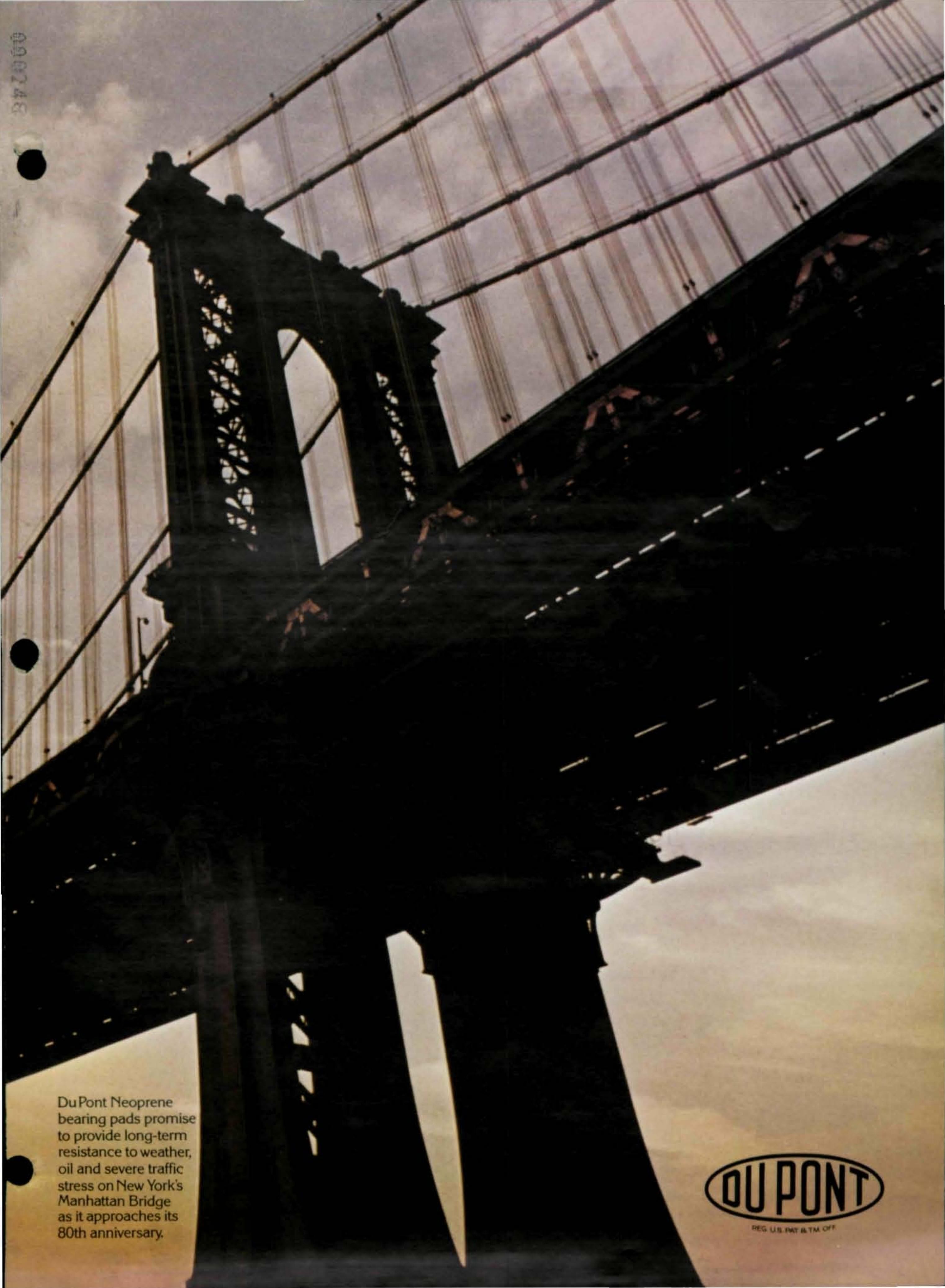
TOP: Du Pont Neoprene window gaskets in the Houston First National City Bank survived severe hurricanes in 1961 and 1983—without a single gasket failure in nearly 8000 windows.

CENTER: Since 1936, a Du Pont Neoprene water-proofing system has prevented gasoline seepage into New York's Lincoln Tunnel.

BOTTOM: Installed in 1969, Du Pont Neoprene adhesive still bonds thermal insulation to the metal apex of the St. Louis Memorial Arch.

(Du Pont makes Neoprene, not the products described.)




Du Pont Neoprene bearing pads promise to provide long-term resistance to weather, oil and severe traffic stress on New York's Manhattan Bridge as it approaches its 80th anniversary.
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Prize Bridges/1984

Steel bridges selected in the national competition conducted by the American Institute of Steel Construction, recognizing bridges that have utilized structural steel aesthetically, imaginatively and economically. All winning bridges were opened to traffic during the period January 1982 through
June 1984.

AWARD CATEGORIES

Long Span
One or more spans over 400 ft. in length.

Medium Span, High Clearance
Vertical clearance of 35 ft. or more, with longest span between 125 and 400 ft.

Medium Span, Low Clearance
Vertical clearance less than 35 ft. with longest span between 125 and 400 ft.

Short Span
No single span greater than 125 ft. in length.

Grade Separation
Basic purpose is grade separation.

Elevated Highway or Viaduct
Five of more spans, crossing one or more traffic lanes.

Movable Span
Having a movable span.

Railroad
Principal purpose of carrying a railroad, may be combination, but non-movable.

Special Purpose
Bridge not identifiable in one of the above categories, includes pedestrian, pipeline and airplane.

Reconstructed
Having undergone major rebuilding.

The American Institute of Steel Construction, Inc. is the voluntary trade association representing and serving the fabricated structural steel industry in the United States. Its purpose is to improve and advance the use of fabricated structural steel and, through research and engineering studies, to develop the most efficient and economical design of fabricated steel structures.

The Institute provides a wide variety of services to the design profession, the construction industry and the steel fabricating companies that support its activities. Programs include development of specifications, technical publications, regional engineering services, research, technical and management seminars, engineering fellowships, programs for quality control, productivity and safety. Among the leading programs, for its effectiveness and lasting impact, is the AISC Prize Bridge Program.

Since 1929, this national competition has recognized the creative, functional and esthetic excellence of modern steel bridges, paying eloquent tribute to the vision and skill of those who plan, design and build them. Noted professionals select those steel bridges judged the most handsome and functional of those recently opened to traffic.

The Bridge Awards and resulting national acclaim continue to inspire designers and builders toward greater creativity and innovation. Contemporary steel bridges combine beauty, economy and reliability, founded on a century of experience. This year's winners reflect that past, and anticipate the future: bridges displaying a creative integration of structure, function and form—all skillfully executed in steel.

Cover photo:
Columbus Drive Bascule Bridge
Chicago, Illinois
(See Prize Bridges, page S-26.)

The Jury of Awards for the 1984 competition are (from left to right):

Stanley N. Allan, President, Harry Weese & Associates, Chicago, Illinois

Charles Seim, Principal, T. Y. Lin International, San Francisco, California

Thomas R. Kuesel, Chairman of the Board, Parsons Brinckerhoff Quade & Douglas, Inc., New York City, New York

Edward V. Hourigan, Director, Structures Design & Construction Division, New York Department of Transportation, Albany, New York

Richard W. Karn, President, Bissell & Karn, San Leandro, California, and President-Elect, American Society of Civil Engineers

BONANZA-WHITE RIVER BRIDGE
Uintah County, Utah

1984 Special Award
Category: Medium Span, High Clearance

Designer: Horrocks Engineers, American Fork, UT
Consultant: D. Allan Firmage, Provo, UT
General Contractor: W.W. Clyde Construction, Springville, UT
Steel Fabricator & Erector: Utah Pacific Bridge & Steel Company, Lindon, UT
Owner: Uintah County, Vernal, UT

This bridge fits into the landscape so beautifully, anyone traveling over it would not realize they were on a bridge were it not for the railings. Yet it was designed and erected with limited budget in 9 months to meet deadlines. Built for AASHTO HS-30 design load, this 3-span welded plate girder structure carries personnel and heavy equipment to the White River Oil Shale Mine & Plant in remote Uintah County.

The haunched weathering steel girders on simple concrete piers are aesthetically compatible with the geology of the area. Should the river be dammed for a lake and recreation area, this almost invisible structure will become a welcome umbrella. For a bridge of this height, span and HS-30 loading in a remote location, with cost under $75 per square ft of roadway, this bridge is spectacular.

VETERANS MEMORIAL BRIDGE
Kaukauna, Wisconsin

1984 Special Award
Category: Movable Span

Designer: Ayres Associates, Eau Claire, WI and Harrington & Cortelyou, Inc., Kansas City, MO
General Contractor & Steel Erector: Lunda Construction Co., Black River Falls, WI
Steel Fabricator: Phoenix Steel, Inc., Eau Claire, WI
Owner: City of Kaukauna, Kaukauna, WI

The vertical lift span was found to be the most economical type of movable span for this bridge crossing the United States Canal in Kaukauna, WI, based on extensive engineering investigations of site conditions, constraints, and preliminary designs. The required overhead construction utilized welded steel fabrication to attain clean, simplified details. All main structural towers and bracing members are welded steel box sections, cost efficient and attractive. The transverse Vierendeel tower bracing strut, also a welded steel box section, was used to simplify the design and fabrication of the towers. It contains operating machinery and controls, easily accessible for inspection and maintenance. The clean, straightforward lines and overall simplicity of the structure result in "a piece of sculpture."

THE GULF BRIDGE
Lockport, New York

1984 Special Award
Category: Railroad

Designer: Bechtel Civil & Minerals, Inc., San Francisco, CA
Consultant: Ralph Whitehead & Associates, Atlanta, GA
GC & Fabricator, Superstructure: Cives Steel Company, Conklin, NY
GC, Substructure: Lane Construction Corporation, Meriden, CT
Steel Erector: Consolidated Steel Erectors, subsidiary of The John W. Cowper Company, Inc., Amherst, NY
Owner: Somerset Railroad Corporation, Binghamton, NY

The Gulf Bridge is a 12-span single track, ballast steel deck structure approximately 965 ft long. The deep valley it crosses, known locally as "The Gulf", required piers as tall as 86 ft above grade. Designed for a Cooper E-72 loading, the design considered the circumferential forces of a 13,000-ton train. The 80-ft long twin girder spans, with a steel deck, are supported on 2- and 4-legged A-frame piers fabricated from 36-in. diameter API oil pipeline steel pipe, a unique solution. The piers, founded on strata of great variability, use caisson foundations up to 97 ft deep. The 1,200 tons of fabricated steel used here create an aesthetically pleasing structure, a major concern to the community. A high-tech solution reflecting an older technology.

R.C.C. PIPERACK BRIDGE
Catlettsburg, Kentucky

1984 Special Award
Category: Special Purpose

Designer: Columbus Engineering Consultants, Ltd., Columbus, OH
General Contractor & Owner: Ashland Petroleum Company, Ashland, KY
Steel Fabricator: Mid States Steel Products Co., Lexington, KY
Steel Erector: Ross Brothers Construction Co., Inc., Ashland, KY

A refreshing solution to an age-old problem, the two arch ribs support a pipe rack arrangement to carry petroleum products over a multi-track right-of-way, a private spur track and an access road. The box girder arch ribs, and all secondary members, were fabricated from A572 high-strength steel with fireproofing material added because of the potentially flammable environment. Erected in three weeks without the need for falsework, the slender circular shape provides a vivid, visual link to adjacent sections of the heavily developed industrial site in the rolling Eastern Kentucky hills. An unusual treatment of a common structure not usually considered attractive.

ELLICOTT CREEK BRIDGE—Park Country Club
Buffalo, New York

1984 Special Award
Category: Reconstructed

Designer: Joseph Freeman, P.E., Buffalo, NY
General Contractor & Steel Fabricator: J.W. Lintner Construction, Inc., Williamsville, NY
Steel Erector: Ernest J. Thorpe, Williamsville, NY
Owner: Park Country Club of Buffalo, Williamsville, NY

Originally built around 1890, the deck timbers, steel stringers and girders in this service bridge finally succumbed to time and could no longer safely carry the heavy maintenance, construction and utility trucks which used it. By using salvaged timbers and steel, the old structure was completely reconstructed for less than budget of $20,000.

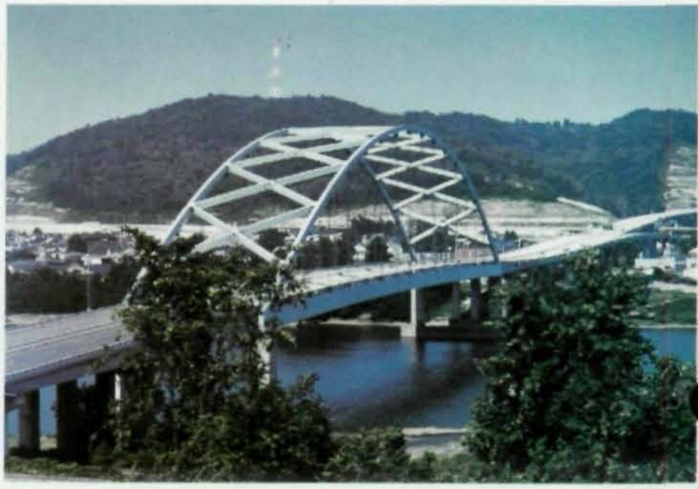
The two main girders, spaced on 9-ft centers were set into refurbished stone abutments. All steel fabrication was done on site with existing trusses remaining in place. A perfect example of updating an old structure for current needs, yet maintaining the original design. As the jury put it: "It's still there, yet capable of carrying modern loads."

I-470 BRIDGE over OHIO RIVER
Ohio County, West Virginia

1984 Prize Bridge
Category: Long Span

Designer: Richardson, Gordon & Associates, Pittsburgh, PA
Consultant: Deeter Ritchey Sippel, Pittsburgh, PA
General Contractor, Steel Fabricator & Erector: Bristol Steel & Iron Works, Inc., Bristol, VA
Owner: West Virginia Department of Highways, Charleston, WV

Spanning 780 ft across the Ohio River, this single-span tied-arch bridge proved both economical and attractive. The tie box girders of A588 steel, 12.5 ft deep and 3.5 ft wide, provide most of the bending stiffness. A514 steel was used for the tapered arch ribs, rising 130 ft above the tie girders. Diamond-type A36 boxed rib bracing was chosen during preliminary design and model studies for architectural expression and economy. The bridge, though massive overall, has a clean, light, open feeling with excellent proportions and details.



When you do it,

KY80 over ROCKCASTLE RIVER
Pulaski-Laurel Counties, Kentucky

1984 Prize Bridge
Category: Medium Span, High Clearance

Designer: Kroboth Engineers, Inc., Lexington, KY
General Contractor: R. R. Dawson Bridge Company, Lexington, KY
Steel Fabricator: High Steel Structures, Inc., Lancaster, PA
Steel Erector: Whalen Erecting Company, Inc., Lexington, KY
Owner: Kentucky Department of Transportation, Frankfort, KY

Steel plate girders were specified by the owner for this rural road bridge. Five framing alternatives were considered and a five-span continuous structure proved the optimum arrangement. The final design avoids undesirable encroachment on the visual horizon from the river and also keeps approach fill above the projected high water elevation. The structural system has longitudinal and transverse stiffeners on the web at the interior girders, allowing minimal use of transverse stiffeners on the exterior face. A well-proportioned span, attention to detail presents a striking total effect.

NORFORK LAKE HIGHWAY BRIDGES
Baxter County, Arkansas

1984 Prize Bridge
Category: Medium Span, Low Clearance

Designer: Howard Needles Tammen & Bergendoff, Kansas City, MO
General Contractor: Massman Construction Company, Kansas City, MO
Steel Fabricator: Kansas City Structural Steel Company, Kansas City, KS
***Steel Erector:** Vogt and Conant Southwest Corporation, Little Rock, AR*
Original Owner: U.S. Army Corps of Engineers, Little Rock District, Little Rock, AR

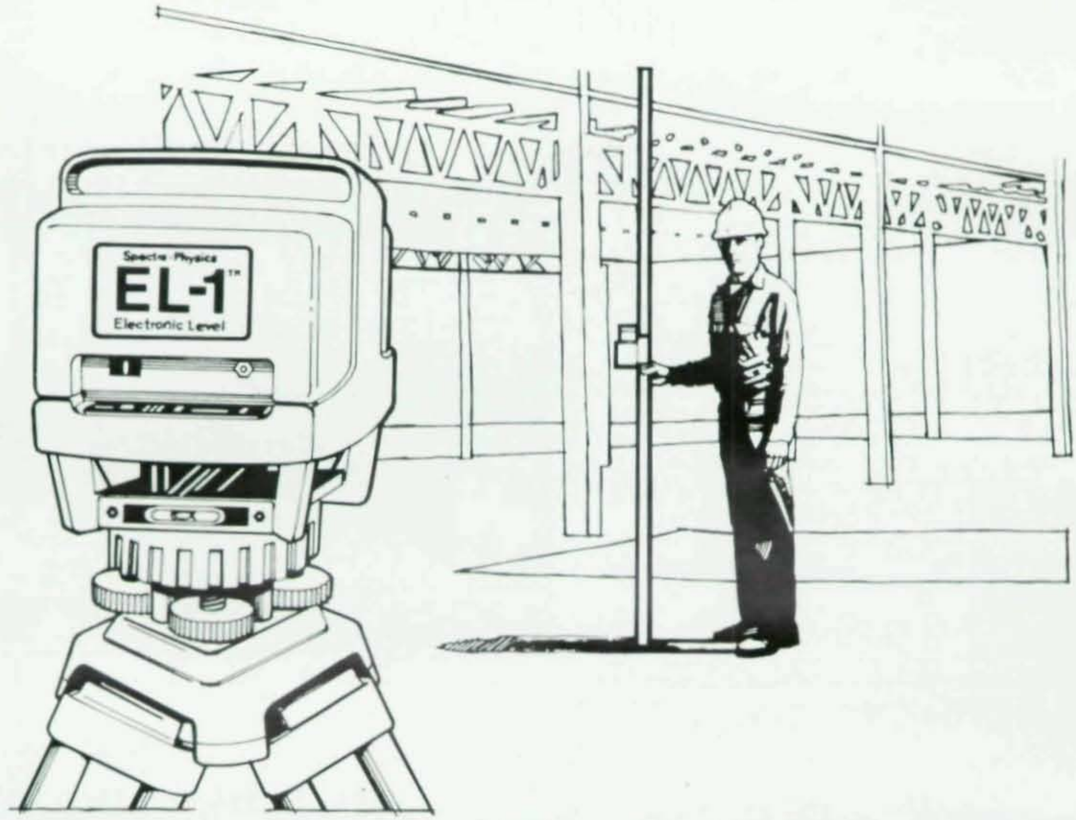
Built to replace ferry boats unable to accommodate increased traffic across the reservoir, these two spans solve the problem with clean, attractive, simple lines. The lightweight superstructure of weathering steel is comprised of two continuous, constant depth, welded plate girders with floor beams and stringers. Of the several structural types studied, steel proved lowest in cost and offered the most appropriate appearance. The lightweight steel girder superstructure is fixed to the pier tops by prestressed anchorages, allowing the use of framed bent-type piers which could be constructed by working above the surface of the water. The superstructure was constructed without falsework or elaborate erection equipment.

SNOQUALMIE RIVER ROAD: BRIDGE 416
Snohomish County, Washington

1984 Prize Bridge
Category: Short Span

Designer: Henningson, Durham & Richardson, P.S., Seattle, WA
General Contractor: Dale M. Madden Construction, Inc., Bellevue, WA
Steel Fabricator & Erector: Fought & Company, Inc., Tigard, OR
Owner: Snohomish County, Everett, WA

This multi-curved steel girder superstructure on a restrictive site proved the most aesthetically pleasing and cost effective solution to replace a deteriorated untreated timber bridge. The slender, sculptural quality of the bridge is accomplished by the overhanging railing and recessed girders on single-column piers. The bridge, with a 210-ft radius, curves gracefully into the landscape at both ends. Built without disrupting traffic on the old bridge, this 272-ft three-span bridge allows higher speeds and load limits than its predecessor, while adding beauty and function to the site.



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GRANBY ROAD OVER STATE ROUTE 137

Kingsport, Tennessee

1984 Prize Bridge
Category: Grade Separation

Designer: Division of Structures, Tennessee Department of Transportation, Nashville, TN
General Contractor: Phillips and Jordan, Inc., Knoxville, TN
Steel Fabricator: Carolina Steel Corporation, Greensboro, NC
Steel Erector: Lyons Construction Company, Rogersville, TN
Owner: Tennessee Department of Transportation, Nashville, TN

The long span capabilities of structural steel enabled the designer to eliminate a medium pier and provide a 30-ft setback from the edge of the lower roadway to the nearest fixed obstacle. The haunched steel plate box girder bridge with composite concrete deck slab has 339-ft long girders, integrally-connected at one abutment and expansion-connected at the other. The girders are uniquely attached to counteract uplift forces of dead and live loading. The final design is a highly attractive, well-proportioned, slender arch that appears to float lightly over the highway.

COLUMBUS DRIVE BASCULE BRIDGE

Chicago, Illinois

1984 Prize Bridge
Category: Movable Span

Designer: Envirodyne Engineers, Inc., Chicago, IL
General Contractor: Paschen Contractors, Inc., Chicago, IL
Steel Fabricator: U.S.S. Fabrication Division, U.S. Steel Corp., Orange, TX
Steel Erector: *American Bridge Div., U.S. Steel Corp., Pittsburgh, PA*
Owner: City of Chicago, Chicago, IL

One of the largest movable bridges in the world, carrying seven lanes of traffic and two 10-ft wide sidewalks, this is Chicago's widest movable bridge. Distance between pivot points is 270 ft. Its beauty and strength is made possible by four welded steel box girders per leaf. Each 6.3 million pound leaf is supported on the outer two box girders. The graceful design takes advantage of innovative welding, fabrication and erection technology. Stronger A588 unpainted weathering steel, fabricated into larger sections for river transport to site, coupled with the sculptured, monolithic effect of welded steel construction, create a new look in bascule bridges.

SEABOARD COAST LINE RR over SAVANNAH RIVER

Elberton, Georgia

1984 Prize Bridge
Category: Railroad

Designer: Prybylowski and Gravino, Inc., Atlanta, GA
General Contractors: Bellamy Brothers, Inc., Ellenwood, GA and Phillips and Jordan, Inc., Knoxville, TN, a joint venture
Steel Erector: Bellamy Brothers, Inc., Ellenwood, GA
Steel Fabricator: Carolina Steel Corporation, Greensboro, NC
Owner: U.S. Army Corps of Engineers, Savannah District, Savannah, GA

This relocated railroad bridge over the Savannah River is part of the R.B. Russell Dam and Lake Project. The vertical clearance will only be 20 ft above final water level. The massiveness of the 136-in. deep welded plate girders spanning 150 ft is almost lost in a panoramic view. Approximately 3,400 tons of steel, mostly A588, was used to fabricate the 16 spans. Girders, each weighing 57 tons, were shop assembled in pairs along with the Vierendeel plate diaphragms, then match-marked, disassembled and delivered to the site. The completed structure is very well proportioned, the maintenance railing helping to emphasize thinness.

SHEEPS CROSSING TRAIL BRIDGE
Madera, California

1984 Prize Bridge
Category: Special Purpose

Designer: U.S.D.A. Forest Service—Region 5, San Francisco, CA
General Contractor, Steel Fabricator & Erector:
E. F. Owens Co., Somerset, CA
Owner: U.S.D.A. Forest Service—Sierra National Forest, Fresno, CA

This hiker's bridge is part of an extensive network of trail systems in the Sierra Mountains and crosses the North Fork of the San Joaquin River. In a highly sensitive environment, the appearance of the bridge could not interfere with the scenic surroundings nor cause construction disturbances to the site. Thus, the designers created a lightweight steel-stayed suspension bridge, shop fabricated and helicoptered to the site in sections with field-bolted connections. To minimize future maintenance, all metal was hot-dipped galvanized. The timber-decked, lightweight, very thin superstructure adds excitement for those who cross.

NEWBURGH-BEACON BRIDGE NO. 1
Newburgh, New York

1984 Prize Bridge
Category: Reconstructed

Designer: Modjeski and Masters, Consulting Engineers, Harrisburg, PA
General Contractor & Erector: American Bridge Division, U.S. Steel Corp., Pittsburgh, PA
Steel Fabricator: U.S.S. Fabrication Division, U.S. Steel Corp., Orange, TX
Owner: *New York State Bridge Authority, Poughkeepsie, NY*

Reconstruction to widen, strengthen and replace the deck of this bridge, now carrying westbound I-84 traffic over the Hudson River, was necessary to accommodate recent high traffic density. Work began immediately upon completion of the new three-lane eastbound bridge. Truss and girder members were strengthened with 775 tons of new steel in 500 top and bottom chords, diagonals and suspenders of the 14 spans in the 7,855-ft bridge. Expanding the roadway from 2 to 3 lanes, the deck was widened by replacement stringers, lengthened and relocated on the truss. Others were added on the outboard edges of the roadway. The 3,000 tons of new A588 high strength structural steel was painted to complement the weathering steel on the new parallel bridge.

LIBERTY BRIDGE
Pittsburgh, Pennsylvania

1984 Prize Bridge
Category: Reconstructed

Designer: Salvucci & Associates, Inc., Pittsburgh, PA
General Contractor & Steel Erector: Dick Corporation/Dick Enterprises, A Joint Venture, Pittsburgh, PA
Steel Fabricator: Atlas Machine and Iron Works, Inc., Gainesville, VA
Owner: Pennsylvania Department of Transportation, Pittsburgh, PA

The most extensive bridge reconstruction and widening project *undertaken in Pennsylvania involved not only the* usual design tasks associated with rehabilitation, but also the development of innovative and complex jacking schemes and repair solutions. The multi-faceted project included repairs to the existing superstructure and substructure components, deck replacement and widening. The replacement of 18 of 20 main truss bearings required the development of three jacking methods. Two of these methods were multi-use schemes, i.e., jacking frames and girders were used repeatedly for various lifts. By unique, imaginative engineering, a functionally and structurally obsolete bridge, 2,663 ft in length with an ADT of over [illegible]0,000 vehicles, was reconstructed into a modern, efficient transportation facility.

1984 Award of Merit
Category: Grade Separation

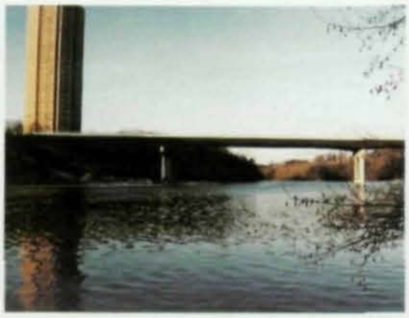
ALGODONES INTERCHANGE
Algodones, New Mexico

Designer & Owner:
New Mexico State Highway Department, Santa Fe, NM
General Contractor & Steel Erector:
A.S. Horner, Inc., Littleton, CO
Steel Fabricator:
The Midwest Steel & Iron Works Company, Denver, CO

1984 Award of Merit
Category: Medium Span, High Clearance

LOCUST STREET VIADUCT
Milwaukee, Wisconsin

Designer:
Bureau of Bridges & Public Buildings, City of Milwaukee, Milwaukee, WI
General Contractor & Steel Erector:
Lunda Construction Company, Black River Falls, WI
Steel Fabricator:
Hartwig Manufacturing Corporation, Wausau, WI & Phoenix Steel Inc., Eau Claire, WI
Owner:
City of Milwaukee, Milwaukee, WI



1984 Award of M
Category: Long Sp

McNAUGHTON BRIDGE
Pekin, Illinois

Designer:
TEC Engineers, Ltd., Northlake, IL
General Contractor & Steel Fabricator:
Bristol Steel & Iron Works, Inc., Bristol, VA
Steel Erector:
American Bridge Division, U.S. Steel Corporation, Pittsburgh, PA
Owner:
Division of Highways, Illinois Department of Transportation, Springfield, IL

1984 Award of Merit
Category: Short Span

WHITECHUCK RIVER BRIDGE

Mount Baker/Snoqualmie National Forest, Washington

Designer:
Federal Highway Administration, Central Direct Federal Division, Denver, CO
General Contractor & Steel Erector:
W.C. McKasson, Inc., Lilliwaup, WA
Steel Fabricator:
Fought & Company, Inc., Tigard, OR
Owner:
U.S.D.A. Forest Service, Pacific N.W. Region, Portland, OR

1984 Award of Merit
Category: Railroad

MARTA AERIAL STRUCTURE over RAILROADS-CS310

Atlanta, Georgia

Designer:
Anderson-Nichols & Company, Inc., Boston, MA
General Contractor:
Moseman Underground Continental Heller, JV, Redding, CA
Steel Fabricator:
Carolina Steel Corporation, Greensboro, NC
Steel Erector:
Erskine Fraiser Company, Decatur, GA
Owner:
Metropolitan Atlanta Rapid Transit Authority, Atlanta, GA

1984 Award of Merit
Category: Viaduct

UNION PACIFIC RAILROAD OVERPASS

Cheyenne, Wyoming

Designer:
Bridge Design Branch of the Wyoming State Highway Dept., Cheyenne, WY
General Contractors & Steel Erectors:
Engineered Structures of Wyoming, Cheyenne, WY & Sletten Construction Company, Great Falls, MT
Steel Fabricator:
Carolina Steel Corporation, Greensboro, NC and The Midwest Steel and Iron Works Co., Denver, CO
Owner:
Wyoming State Highway Department, Cheyenne, WY

1984 Award of Merit
Category: Medium Spa Low Clearan

GREEN RIVER BRIDGE
Uintah, Utah

Designer:
E.W. Allen & Associates, Salt Lake City, UT
General Contractor:
W.W. Clyde & Company, Springville, UT
Steel Fabricator & Erector:
McNally Mountain States Steel Co., Lindon, UT
Owner:
Uintah County Commission, Vernal, UT

1984 Award of Merit
Category: Grade Separation

MERRITT PARKWAY OVER ROUTE 8
Trumbull, Connecticut

Designer:
Seelye Stevenson Value & Knecht, Inc., Stratford, CT
General Contractor:
Arute Brothers, Inc., New Britain, CT
Steel Fabricator & Erector:
The Standard Structural Steel Company, Newington, CT
Owner:
Connecticut Department of Transportation, Wethersfield, CT

1984 Award of Merit
Category: Special Purpose

NORTH BIKEWAY BRIDGE over GREAT MIAMI RIVER
Dayton, Ohio

Designer:
Lockwood, Jones & Beals, Dayton, OH
General Contractor:
Miller-Valentine Corporation, Dayton, OH
Steel Fabricator:
Mound Steel Corporation, Springboro, OH
Steel Erector:
J & N Steel Erection Co., Inc., Cincinnati, OH
Owner:
The Miami Conservancy District, Dayton, OH

1984 Award of Merit
Category: Medium Span,
Category: Low Clearance

LEATHERWOOD FORD BRIDGE
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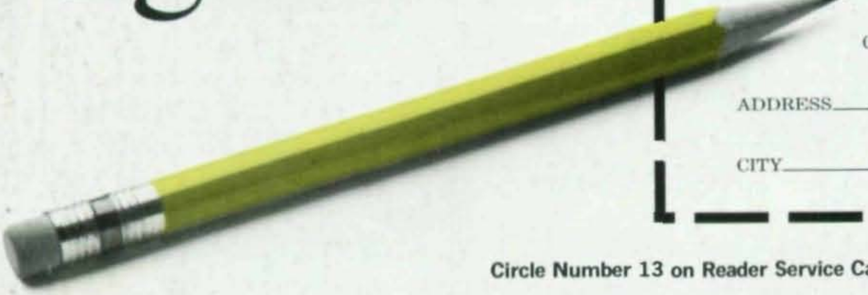

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