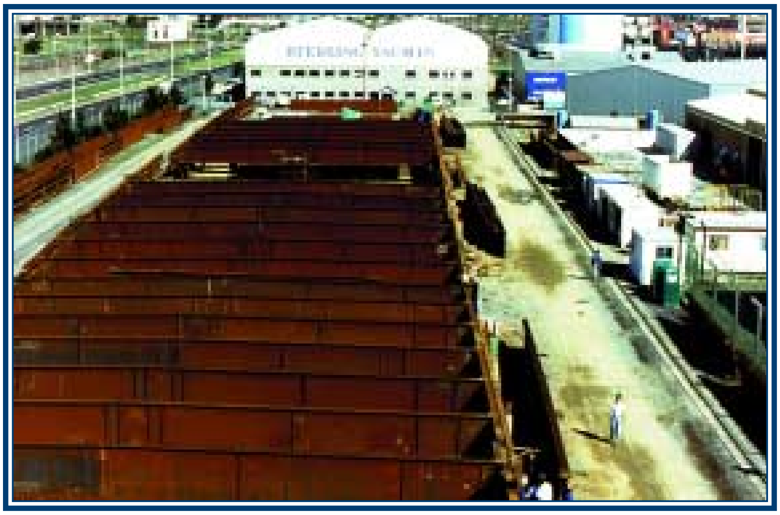
1996 Merit Bridge Award: Long Span
The Fred Hartman Bridge



Judges Comments:

"Unique appearance with good details"

"A beautiful structure"

The Fred Hartman Bridge over the Houston Ship Channel, with a total length of 2,475', is currently the second largest cable-stayed bridge in terms of overall deck area. The bridge connects Loop 201 in Baytown with Texas Route 225 in LaPorte—a distance of about 2.5 miles—and replaces the obsolete Baytown tunnel, which opened in 1953.

The bridge is particularly noteworthy for its "double-diamond" tower configuration which was designed to resist hurricane-force winds. The tower resists transverse loadings through truss action, thereby allowing the very slender 7' leg width since there is virtually no transverse bending.

The main span unit consists of a five-span structure, comprising three cable-stayed spans of 482', 1,250' and 482', and two simple-span flanking units at 130'-6" each. The three-span cable-stayed portion is constructed with a composite steel superstructure.

The typical section consists of two independent roadways, each approximately 78' wide, which carry four lanes of traffic with full shoulders.

The superstructure framing system is very straightforward. It utilizes an 8"-thick reinforced concrete slab supported by transverse floor beams, which are spaced approximately 16' apart. The floor beams frame into main girders, which are located along the outside edge of the section. The resulting steel grid is composite in both the longitudinal and transverse directions. A 4" reinforced concrete wearing surface is placed over the 8" structural slab.

A steel anchor box assembly provides the stay cable anchorage to the main girder. The anchor box is fabricated into a channel-shaped section and is bolted to the main girder web. This allows a direct introduction of the stay cable force into the girder web. This framing system is utilized throughout the cable-stayed main span, except at the ends of the structure, where a main girder web is introduced. The arrangement creates a box structure to anchor the three backstay cables.

SOLVING PROBLEMS

WHILE THE FRAMING SYSTEM WITH THE OPEN MAIN GIRDER SECTION provided greater economy than would a closed box element, it had the drawback of small torsional stiffness of the deck. To supply the necessary torsional stiffness, the stay cables were inclined transversely.

Another difficulty was that the anchor box attachments to the main girders provide for a direct introduction of the stay cable force into the main girder; however, this attachment results in an eccentricity between the stay and web and introduces a substantial torsional moment at each anchorage. Rather than provide lateral bracing to the main girder bottom flange, a full-depth floor beam was located adjacent to each anchorage to resist this torque. The result is that the torque is resisted by a force couple: the top compressive force is resisted by the deck slab and the tension force is taken by the floor beam bottom flange.

Studies were undertaken to determine the cost advantages of a single deck versus a twin roadway system, with the latter proving to be most economical.

The structure employs a bolted steel anchor box to attach the stay cables to the main girders—the first time the project's designers are aware of a cable-stayed structure employing this system. This solution was developed to avoid the more traditional welded anchorages, which require heavy stiffener/attachment weldments that are difficult to control. The bolted anchor box allowed the fabrication of the main girder to proceed independently of the anchor box fabrication. This is beneficial in that, if ever damaged in service, the bolted anchor box can be readily replaced. Input on the system was provided by a panel of steel fabricators and AISC Marketing, Inc.

The main girders are fabricated in 50' lengths. Rather than requiring a cambered shape for each individual main girder section, the elements were fabricated on a chord. The camber was achieved by the relative rotation of adjacent main girder segments. This avoided the expense of fabricating camber into the individual members.

Project Team

Designer:
Greiner Engineering, Inc.
Tampa

General Contractor & Erector:
William Brothers Construction Company, Inc.

Fabricators:
Group Five Ltd.
Johannesburg, South Africa
Trinity Industries
Houston

Owner:
Texas Department of Transportation

Project Data

Steel wt./sq. ft. of deck: 29 lbs.

Cost: $55 million (main span)

Steel tonnage: 5,043