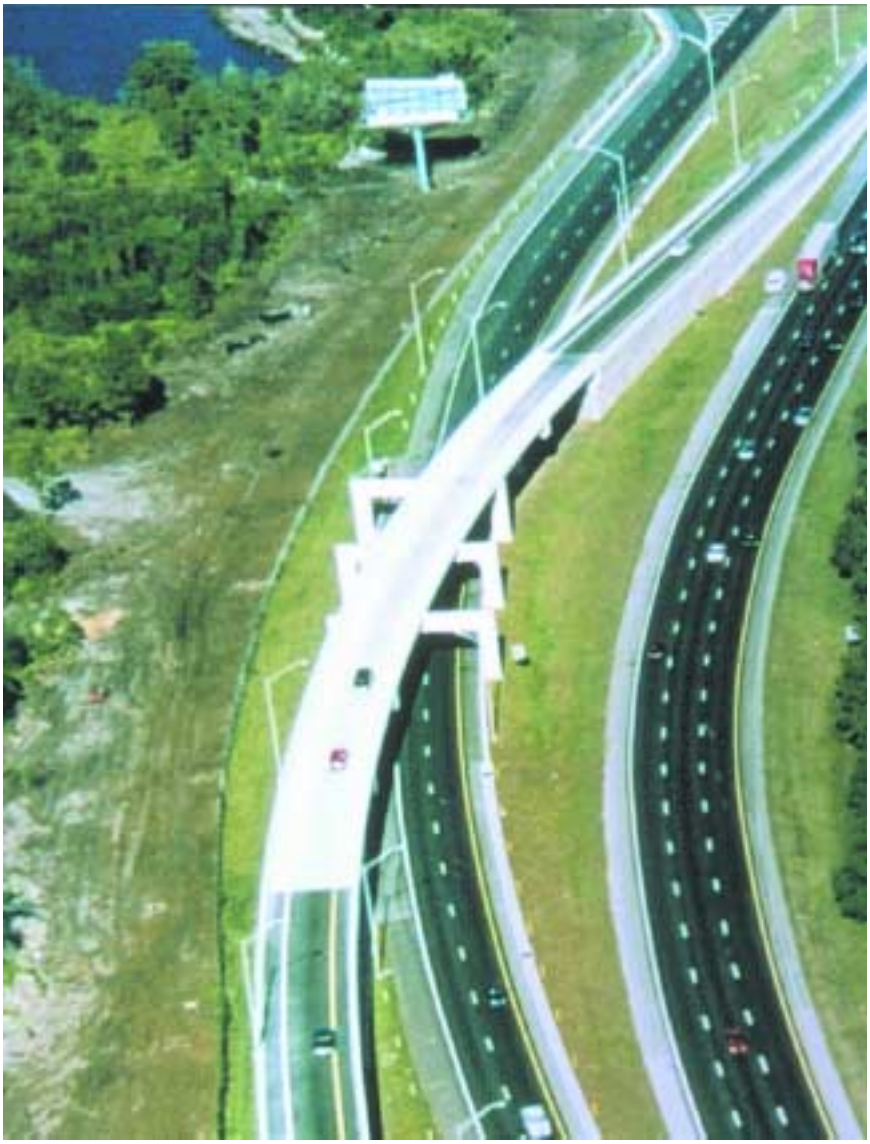
Ramp H over Westbound C/D Republic Drive/I-4 Interchange

Orange County, Florida



The Universal Boulevard (Republic Drive) /I-4 Interchange, provides direct access to a major theme park, Universal Studios, and eases traffic congestion on one of the busiest stretches of I-4 in Orlando, Florida. The new Ramp H over the westbound C/D Bridge is part of the Republic Drive / I-4 Interchange which carries one lane of traffic from westbound I-4 to Universal Studios and the surrounding community. The Ramp H bridge represents a unique, economical and yet aesthetically appealing solution to the complications imposed by crossing a braided ramp with severe skew. URS Greiner Woodward Clyde served as a subconsultant to Ivey Harris & Walls and was responsible for the design of all three grade separation structures planned for this interchange.

Bridge Description

The new bridge consists of seven equal spans, simply-supported, with 88' per span, making a total bridge length of 616'. The bridge alignment follows a mild 2.25 degree curve. The deck width is 30' and consists of an 8-inch-thick concrete deck slab supported by and composite with three lines of W36 × 245 rolled steel beams (Grade 50). The substructure piers are aligned radial to the baseline and consist of four hammerhead piers and three straddlebent piers located at the central portion of the bridge length. The piers are conventionally reinforced concrete supported on pile foundations.

Design Challenges

Although the bridge crosses over a two lane roadway only 46'-6" wide it includes travel lanes, shoulders and traffic barriers, the required minimum bridge length is in excess of 600". This is a result of severe 82.5 degree skew

between the two roadway alignments. Additionally, to provide the required minimum vertical clearance of 16.5' for the lower roadway the structure depth was limited to a total of 7'. This is a result of two roadway geometric constraints on the vertical profiles: the lower roadway profile could not be dropped due to the high water table and its affect on the roadway subgrade and the bridge profile could not be raised due to the close proximity of an at grade intersection to the west and the I-4 exit ramp tie-in to the east.

Design Solutions

A common solution for relatively narrow structures with severe skews, such as the one found here, is a bridge structure with a continuous superstructure and single column piers along the bridge centerline. However, although this would minimize the main span length the resulting span length required would be in excess of 300', which was unacceptable given the structural depth constraints. During the bridge development phase of the project, two general bridge types utilizing short span lengths were evaluated: a single span structure with AASHTO beams framed transverse to the direction of traffic and supported with two long substructures running the length of the bridge on each side and a multi-span structure with beams framed parallel to traffic and supported with hammerhead piers where space permits, and straddle piers otherwise. Based on preliminary construction cost estimates, the transversely framed option was significantly more expensive (approximately 50%) and aesthetically undesirable. The longitudinally framed option was developed further to compare AASHTO type beams and rolled steel beams. For identical span arrangements, a direct cost comparison between the beam types showed them as being essentially equal in cost (within 6%). Rolled steel beams were selected based on aesthetic and lightweight considerations, and to provide consistency with the two other steel plate girder bridges within the interchange.

Design Economy

With a total structural depth limitation of 7' (including pier cap depth), a maximum rolled beam depth of 36" was available for structural optimization. A seven span arrangement with three girder lines using W36 × 245 rolled steel beams was found to be the most economical, resulting in approximately 25 lb. per square foot of structural steel deck area. A generous beam spacing of 10' with overhangs averaging 5' optimized the capacity of the beams and the 8" thick deck slab. The beams are simply-supported by piers with inverted "T" cap cross-sections. The use of shorter, simple spans benefited the overall bridge economy in several ways:

- Standard rolled beam shapes could be used that are easily shipped with no field splicing;
- The discontinuity at the beam ends allowed the structural section of the pier cap to extend into the superstructure and reduce the overall structural depth. This is achieved without the complications of an integral pier cap;
- The superstructure dead load reactions were minimized allowing for straddle piers designed using reasonable proportions.

Based on project bid tabulations and final quantities, the total construction cost for the bridge (excluding retaining walls) was $1,172,000, which equates to a unit cost of $63.43 psf of bridge.

Aesthetics

Although the substructure may be the predominant aesthetic feature of the bridge's overall appearance the relative proportions of the substructure and superstructure, and the variations in which they intersect, allow for the two to blend together as one form adapting to the site. The pier columns, which are in a sustained and direct view from the lower roadway traffic, utilize rusticated surfaces to soften the appearance of the large column faces. The bridge also has the unique feature of displaying its unique aesthetic appeal to those traveling under the bridge.

Project Team

Owner
Universal City Development Planners

Designer
URS Greiner Woodward Clyde

Steel Fabricator
Carolina Steel Corporation

Steel Detailer
ABS Structural Corporation

Steel Erector
V & M Erectors

General Contractor
Hubbard Construction Company