# Steel Spans the Neuse River

By Gregory R. Sigmon, P.E.

Located 20 miles from the Atlantic Coast in New Bern, NC, the Neuse River Bridge opened to traffic in the fall of 1999. Culminating the North Carolina Department of Transportation's (NCDOT) largest single transportation project ever completed, the $120,000,000 project carries an estimated 55,000 vehicles per day across the river and over a heavily traveled channel. A challenge from the start, the project called for the construction of a bypass of US 17 and NC 55 around the town of New Bern, making a nearly 2-mile, high-level fixed span crossing of the Neuse River and an adjacent interchange a necessity.

By virtue of the various grade separations, the layout for the bridge required 8 ramp/loop bridges and a tri-level interchange on the west with bridges varying from (100m) 300' to 950m (3,200') in length with curvatures as sharp as 100m (300'). Furthermore, the numerous ramp and loop terminals created "wishbone" shaped transition zones, which complicated span framing even more.

In 1993, NCDOT selected a team of engineers headed by Ralph Whitehead Associates, Inc., (RWA), out of Charlotte, NC, to provide design services for the project. The contract consisted of vessel impact studies, bridge type studies, preliminary and final plans. For the bridge type studies, concrete and steel box girders, prestressed concrete girders and structural steel plate girders were considered as viable superstructure alternates. A comprehensive study evaluated alternates by using the following factors as measurements:

- ease of constructability = 20%;
- initial estimated construction cost = 40%;
- aesthetics = 20%; and
- long-term maintenance costs = 20%.

For the tri-level interchange and the main bridge, structural steel plate girders were chosen. The complex geometry drove this decision for which framing via steel girders was deemed advantageous. Additional considerations for steel included the need for unusually long spans to mitigate expensive foundation costs, the reduction in crane lifting requirements and the desire for continuous span layouts throughout.

The bridge design provided several challenges to the designers, including:

- varied geometrics (curves, spirals, tapers, etc.);
- five transition zones;
- tight horizontal and vertical clearances (over 100 points checked);
- huge overhead signs, subjected to hurricane wind forces;
- aircraft warning lighting system; and
- metric detailing.

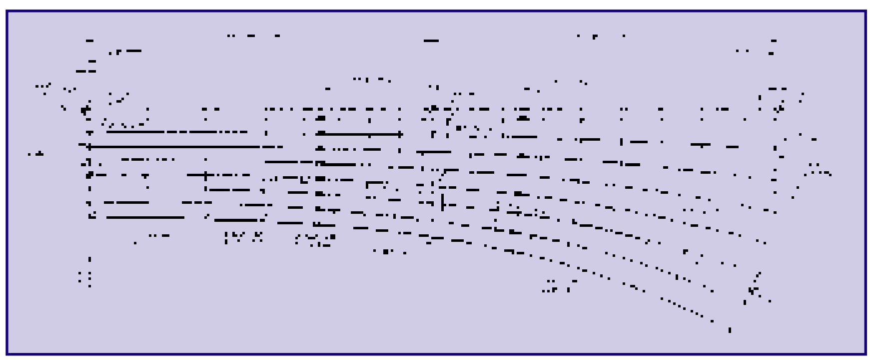
These challenges handled individually do not present an overwhelming concern, but when coupled with the schedule (10 months to do the final plans), plus the need to produce consist detailing and plans among five firms, communication was of paramount importance. The RWA team and NCDOT employed a system of monthly meetings, mass communication faxes and unique design memos to facilitate the design and plan production. The end product was a set of 1,500 construction drawings that provided consisted detailing amongst all the bridges.

The superstructures required 11,447,550 kg (approximately 12,620 tons) of structural steel. Structural steel was chosen for the superstructure because of its ability to adapt to difficult roadway geometry and to provide long span capability. In transition zones, the field section of a girder within a curved continuous unit would utilize a different radius than the next piece. This alignment would create a "compound curve point" at the field splice. A total of 678 bolted field splices minimized the shipping lengths and facilitated construction.

The span layout varied from 30m to 46m (98' to 150') except at the channel. The river crossing alignment produced two "channel" spans (Main Bridge and Ramp DC) with a main span of 80m (260'). The minimum clearance requirements at the channel required 19.8m (65') of vertical clearance above high water and 55m (180') of horizontal clearance. The additional horizontal clearance provided eliminated the need for a protective fender system.

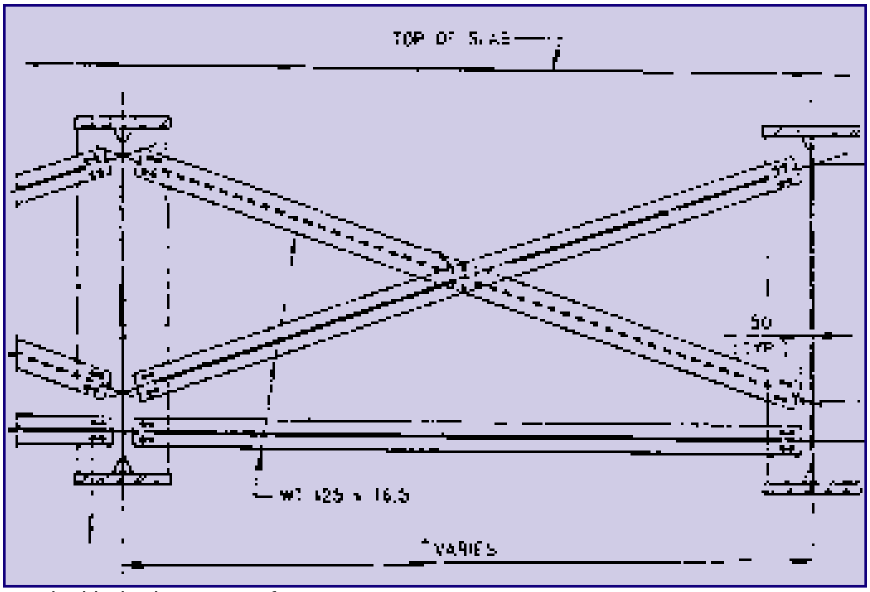
The framing plans used a typical girder spacing of 3.6m (12') on average; however, in the transition zones, a flared girder arrangement was considered. Although girder spacing had to vary in transition zones, a girder spacing of 4m (13') was set as the upper limit. The typical sections varied from three girders in the section on Ramp DA to 11 girders in the typical section for the six lane wide channel unit of the Main Bridge. For aesthetics, a web depth of 1600mm (63") was maintained almost entirely throughout the interchange. A 2290mm (90") web depth was used for the continuous unit at the 80m (260') main channel.

The plate sizes for the top and bottom flanges varied from 20mm to 68mm (3/4" to 2 3/4") thick and from 300mm to 720mm wide (12" to 28 3/8"). The web thickness varied from 12mm to 20mm (1/2" to 3/4"). For the fabrication of the curved girders, heat curving was allowed.



*Framing plan at a transition zone.*

*View of one of the numerous "wishbone" rinterchanges throughout the structure.*




*Typical bolted "X" cross-frame.*

The crossframes consisted of "K" type bolted frames and "X" cross-frames. Over 1,800 cross-frames were included in the bridges, most of them designed to resist the torsional stresses produced by horizontal curvature.

All structural steel was AASHTO M270 Grade 50 and painted gray to match the concrete and to provide an aesthetically pleasing appearance. Additionally, the paint provided for an additional measure of corrosion protection. The project location dictated the need to provide typical NCDOT measures for corrosion protection (extra cover, epoxy-coated rebar, denser concrete, etc.). Bolted connections utilized M22 (approx. 7/8") galvanized high strength bolts conforming to ASTM A325M Type 1.

The design of the structural steel superstructures involved several computer programs. For the straight portions, MERLIN-DASH was utilized. DESCUS was used for the curved girder design. Additionally, finite element analysis from BSDI was employed for the severely curved loops. In-house software designed the bolted splices, bearing stiffeners, etc. This array of structural steel programs provided the correct tools to do the job quickly and efficiently.

Traylor Brothers, Evansville, IN, was the low bidder for the main river crossing and interchange work, and began work in late 1995. Despite five major hurricanes, the project was opened ahead of schedule and without major claims or fatalities. The total construction cost was almost $28,000,000 below initial estimates.

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**Owner:**
North Carolina Department of Transportation (NCDOT)
Raleigh, NC

**Structural Engineer & Project Management:**
Ralph Whitehead Associates, Inc., Charlotte, NC

**Steel Fabricator & Detailer:**
PDM Bridge, Eau Claire, WI

**Software:**
MERLIN-DASH, DESCUS, BSDI

**Additional Structural Engineers:**
HNTB, Raleigh, NC,
Parsons Brinckerhoff, Raleigh
Barbara H. Mulkey Engineering, Raleigh
DS Atlantic, Raleigh
Hall-Wilson, Winston-Salem