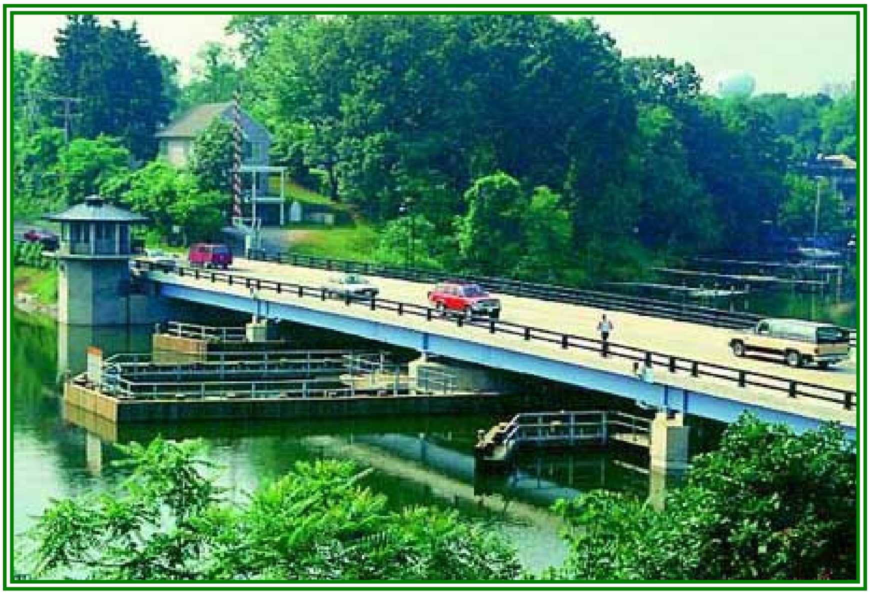
Merit Award: Moveable Span

WEEMS CREEK BRIDGE



The new Ridgely Avenue (MD 436) Bridge over Weems Creek is a modern steel composite structure in harmony with its intimate waterfront and wooded residential surroundings. The new bridge replaced a structurally deficient 1920's era pony truss swing span with trestle approaches. Like its predecessor, the new bridge includes a swing span, but the new movable span is skillfully blended with its approaches to form a consistent presentation. The creek's banks are now joined by a band of steel gliding low over the serene waterway. Since its opening, the new bridge has been enthusiastically received by its neighbors as well as highway and marine users.

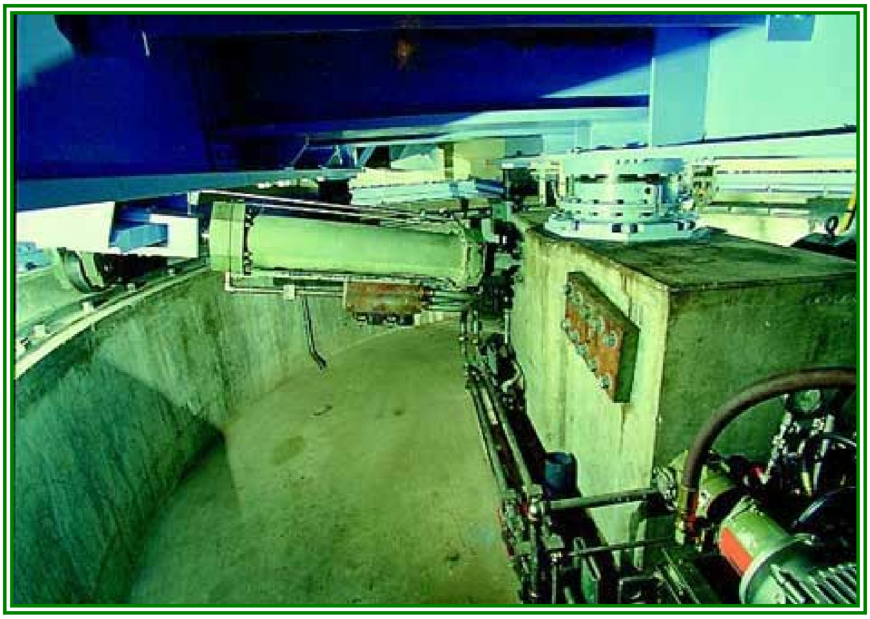
Weems Creek flows into the Severn River, forms the northern boundary of historic Annapolis, Maryland, and harbors numerous recreational sailboats and powerboats. Ridgely Avenue is a picturesque rolling wooded highway providing unhurried access to Maryland's capital and the U.S. Naval Academy. The rural and residential character of Ridgely Avenue was preserved when post-war construction of nearby Rowe Boulevard provided a high-level crossing and quicker access to the city. The old bridge on Ridgely Avenue remained a comfortable reminder of the stability and permanence of the Weems Creek community. The design for the new bridge was conceived to provide a dignified structure with a scale and details appropriate to and respectful of this picturesque site.Replacement Structure

The replacement structure is built on the alignment of the original bridge, but it improves the roadway width from 20' to 30' clear and provides a new 5' wide sidewalk on the upstream side. At the north end of the bridge, a horizontal curve is introduced to eliminate an abrupt 14-degree kink in the road. The original level grade of the old bridge is now replaced by a gently rolling profile with the high point over the pivot of the swing span. The new structure has the same under clearance that the old bridge provided when the swing span is closed.

The bridge superstructure has five steel plate girders, 46" deep, and supporting a reinforced concrete deck. Shear connectors welded to the top flanges of the plate girders provide composite action with the deck and economize the plate girder design.

The superstructure is fitted with special tubular traffic railings mounted on low concrete curbs. Low-level illumination of the sidewalk is provided by light standards on the sidewalk side. The lighting is sufficient for pedestrian security while not imposing high lighting levels on the community. The superstructure consists of three units. The north approach has two spans with equal span lengths of 87‘. The swing span unit has two continuous 62’ spans when closed. These spans freely cantilever from their pivot point when the movable span is opened. The south approach is a single span with a 54’ span length. The overall bridge extends 360’ between abutment bearing cantilevers.

The approach pier and rest piers consist of reinforced concrete solid shafts supported just below the water’s surface by steel pipe piles filled with reinforced concrete. The circular reinforced concrete pivot pier is elongated to support bearings for the fascia girders and to have its projecting ends present a similar appearance to the approach and rest piers. The pivot pier is also pile supported just below the water’s surface which avoids the high cost of deep cofferdam construction. Full height reinforced



Weems Creek Bridge

Owner:
Maryland State Highway Administration

Designer:
URS Greiner Inc., Hunt Valley, MD

GC & Erector:
Cianbro Corporation, Baltimore (NSBA Member)

Fabricator:
Williams Bridge Company, Manassas, VA (NSBA Member)

Detailer:
Alabama Structural Detailers, Trussville, AL

concrete abutments end the bridge at the water's edge and join with long retaining walls supporting the approach fills adjacent to the creek. The concrete fascia and railing continue from the bridge onto the wingwalls and retaining walls. A two-level octagonal-shaped operator's house was proportioned to the minimum size possible by placing access stairways on the outside. The operator's house is nested with the south abutment on the downstream side of the bridge. Traffic control, warning gates, and resistance gates necessary for the movable span are mounted on the retaining and wing walls and were kept off of the spans over the creek.

Movable Span

A technical jewel embedded within the bridge, the steel composite center bearing swing span and its hydraulic operating system, introduce many significant innovative departures from conventional practice in movable bridge design. The old belief that the lightest structure possible is essential for economy in a movable span has been proven invalid when a modern, hydraulic drive system is used. For this structure, economy is achieved by continuing steel composite construction (with normal weight concrete deck) across the moving spans. At the center of the swing span unit, two parallel steel pivot girders are fitted between and spliced above the longitudinal girders to transfer all of the moving span's weight to the centerline girder. Full depth bearing stiffeners then deliver the load to a low profile pivot bearing with circular bronze and steel discs contained within a lubricant bath provide the turning surface. The pivot bearing is mounted on a 10' long, 4' wide concrete plinth aligned with the center girder and rising 5.5' above the machinery room floor. The circular machinery space is hollowed within the low profile pivot pier.

To drive the bridge, two 12" bore hydraulic skewing cylinders are clevis mounted on spherical pivot points located on the fore and aft shoulders of the pivot plinth. These powerful arms reach out and up to grasp the span at weldments attached to the pivot girders. The slewing cylinders push the span open and pull it shut through a 75 degree operating arc. When fully opened, the swing span allows unrestricted passage through two, 28' wide channels. Timber fenders and a draw rest protect marine traffic. During bridge openings, the stability of the swing span is maintained by eight 12" diameter balance wheels mounted below the center three girders and the pivot girders. The wheels glide above a circular steel track placed on a continuous ledge bordering the machinery space. A circular welded steel plate machinery enclosure is fitted between the structural framework and extends from the concrete deck to a concrete perimeter curb on the pivot pier. The machinery enclosure resembles the turret of a warship and protects the hydraulic mechanisms. The inner surfaces of the steel machinery enclosure are insulated and finished, and a heating and ventilating system and dehumidifier control the machinery space environment. The concrete curb on the pivot pier is well above extreme high water levels. This high freeboard protects the machinery space against flooding.At the ends of the swing span, the interior longitudinal girders frame with a horizontally curved, full depth end floorbeam with the flanges offset to the outside of the curve. Each curved end floorbeam connects with the bearing stiffeners and flanges of the fascia girders. Directly below these connections, spherical end bearings with slider-mounted sole plates transfer the end reactions to the rest piers.

When the span is closed, these end bearings carry sufficient positive dead load reactions to avoid uplifting under in-service loadings. Slider-mounted live load shoes are also provided to secure the exterior girders over the pivot pier. The fully closed span responds to live load as a two span continuous structure.

Four hydraulic end lift jacks are placed on the inside surface of the end floorbeams centered between the first interior and fascia girders. To initiate an opening, the end lift jacks extend and push against strike plates on the rest piers, raising the bridge ends about 1". With the ends lifted, the sliding shoes are withdrawn by hydraulic rams operating linkages that simultaneously withdraw both sliding sole plates at each end of the bridge. The live load shoes on the pivot pier are also withdrawn by direct action of hydraulic rams. Once all shoes are disengaged, the end lift jacks lower the bridge ends, and the bridge is turned open by the slewing cylinders. The process is reversed to close the span. The end lift jacks and hydraulic units controlling the shoes are all hydraulically operated from within the enclosed machinery space on the pivot pier. To protect the piston rods of the hydraulic power units, all are arranged to extend (push) to open the span and contract (pull) to restore the bridge to the fully closed position. The arrangement of the hydraulic machinery developed for the Weems Creek Bridge is unique to this structure.

Construction

Bids for construction were received in late September 1995. The contract to remove the old bridge and build its replacement including all roadway approach work was awarded to Cianbro Corporation based on their low bid of $5.8 million.

During construction, Ridgely Avenue was closed at the bridge and vehicular traffic detoured. Marine traffic was continuously maintained by a temporary shift of the channel to an alignment north of the new swing span unit. The swing span could then by conveniently constructed in the closed position. When nearly finished, the movable span was opened and marine traffic redirected to the normal channel as the remaining gap in the north approach was filled.

A special erection procedure was specified for the swing span to prevent placing the concrete deck in tension as the span ends are lowered to operate the bridge. The steel girders were initially blocked 3" above their intended elevation at the rest piers while all splices and connections were fully bolted. The end blocking was then lowered by 5" to a position 2" lower than final grade and the ends pulled down to the block points by jacking prestressing bars anchored into the rest piers and temporary weldments mounted on the end floorbeams in the locations where the end jacks would later be installed. Concrete counterweights (to balance the weight of the unsymmetrical sidewalk) were then placed in each span inside of the fascia girder on the downstream side. The deck was subsequently placed in stages to the lowered position of the deflected spans. Once all of the sidewalk and curb concrete placements were completed, the anchored ends were released which resulted in a slight rebound and precompression of the deck. With the end lift cylinders installed and operated, the level of compressive stress varies in the deck but the concrete is not subjected to tension.

The new bridge was opened to traffic in November 1997. The new Weems Creek Bridge is located in a picturesque site. Particular attention was paid to designing an attractive replacement structure in character with its surroundings. To integrate the swing span into the overall theme of the bridge, the moving superstructure uses the same construction as the approaches. Selection of a steel composite multi-girder swing span proved highly economical compared with lighter weight superstructure alternatives. A unique hydraulic operating system drives the structure with most of the equipment hidden from view in a secure, climate controlled machinery space on the pivot pier. Care was taken to proportion the pivot pier to coordinate its shape with the approach and rest piers. The pile-supported piers appear as solid shafts projecting from the creek's surface; however, they were economically built without deep cofferdams as elevated platforms. A special erection and deck placement procedure was used to eliminate tension from the composite deck. Special railings, sidewalk lighting, and a compact operations house all complement the structure.