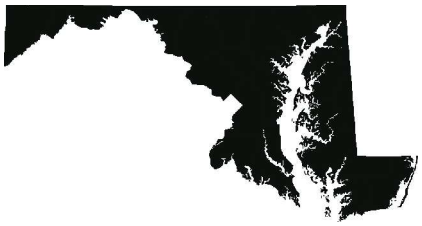
Maryland



by Jeffrey Robert and Justin Mohr, Maryland Department of Transportation

Maryland is located on the East Coast of the United States and shares its borders with four states and the District of Columbia. The state is often referred to as "America in miniature," because of its varied terrain and climates, its role in American history, and the diversity of its residents. Western Maryland is rural and mountainous and experiences heavy snow in the winter. Central Maryland is densely populated, has moderate snowfall in the winter, and experiences extreme heat in the summer. Eastern Maryland has a mix of rural and urban areas, and the Atlantic shoreline is extremely flat. The eastern region experiences minimal snow accumulation but is occasionally affected by hurricanes.

The highway system maintained by the Maryland Department of Transportation State Highway Administration (MDOT SHA) has 2567 bridges, including 511 concrete beam/girder superstructures. In general, the MDOT SHA Office of Structures uses concrete superstructures for bridges over any body of water. The type of beam or girder used at a given location depends on the span length.

Bridge Specifications and Policies

For water crossings spanning less than 55 ft in length, prestressed concrete slab panels are the "go to" bridge type for two reasons. First, this bridge type lends itself to accelerated bridge construction. The superstructures consist of 3- or 4-ft-wide prefabricated, prestressed concrete solid slab elements. Each slab panel must be fabricated using self-consolidating concrete with a required 28-day compressive strength of 8 ksi. Once all the slab panels are set, the slabs are transversely post-tensioned together so the slabs will act in unison. To provide a smooth riding surface, a 5-in.-minimum thickness concrete overlay with synthetic fibers and with either epoxy-coated or polymer-fiber reinforcement is placed. The railing is typically a prefabricated metal railing bolted to the superstructure.

The second reason that the slab-type structure is the preferred bridge option for Maryland's small water crossings is because it can provide a relatively maintenance-free bridge for the life of the structure. MDOT SHA has set the minimum clear cover to the prestressing strands at 3 in., providing extra protection for the one element that could potentially corrode if exposed to chloride-laden water. The structures are also constructed without joints. The elimination of the joints protects the abutments from potential exposure to chloride from roadway deicing salts.

The substructures for these shorter bridges vary based on the site location and conditions. Both precast concrete and cast-in-place concrete elements have been used. Every summer, three or four of these slab-type bridges are constructed in Maryland under a complete road closure and detouring of traffic. The prefabricated elements allow for the complete replacement in fewer than 10 weeks, which means the roadway is open to traffic before schools open in the fall.

For larger water crossings requiring greater than 55-ft span lengths, MDOT SHA uses precast concrete economical fabrication (PCEF) bulb-tee prestressed concrete girders. Like its prestressed concrete slabs, Maryland's PCEF girders are fabricated using self-consolidating concrete with a required 28-day compressive strength of 8 ksi. The use of the PCEF girders is common in many states across the country. Some of the policies and practices that MDOT SHA has adopted regarding these beams are described here.

In response to the concerns raised during years of field inspections about problematic details, MDOT SHA adopted policies to reduce maintenance requirements for the prestressed concrete girders used in bridges. Prestressing strands are not debonded, and the minimum concrete clear cover on the bottom of girders has

Bridge No. 03109 – U.S. Route 40 over Patapsco River. Photo: Maryland Department of Transportation State Highway Administration.

Bridge No. 15033 – Maryland Interstate 195 over Sligo Creek Parkway and Sligo Creek. Photo: Johnson, Mirmiran & Thompson.

been increased from the American Association of State Highway and Transportation Officials' minimum to 3 in. These changes in design practices have slightly increased initial costs; however, MDOT SHA believes that this initially higher expense will be offset by a reduced life-cycle cost.

Another problematic maintenance issue for Maryland has been leaky roadway expansion joints, which contribute to deterioration of bearings, girder ends, and abutment beam seats. To address this issue, Maryland has revised its policies and modified details in the last five years. On a policy level, Maryland has eliminated the expansion joint for bridges in which all spans contributing to expansion have lengths of 70 ft or less. This change essentially makes the structure fixed at all substructure units. MDOT SHA has determined that, for this length, flexibility in the bridge superstructure is sufficient to accommodate expansion or contraction movements, as well as other horizontal movements, without causing duress to the bridge.

When expansion or contraction from lengths of more than 70 ft must be accommodated, a compression-seal joint is used. However, the details have been modified to extend the deck beyond the abutment backwall by 6 in. A grade beam beyond the abutment is built, which is supported on support columns cast on the footer and the back side of the abutment, and the compression-seal joint is set between the grade beam and the extended deck. Any failure of the compression seal at this location will not result in chloride-laden water running onto the bearings or abutment beam seats, which eliminates a long-term maintenance issue. This detail does not require an approach slab.

Bridge Preservation

In recent years, another focus area for Maryland has been bridge preservation. MDOT SHA's inventory of structurally deficient bridges is presently less than 3% of all bridges. As Maryland strives to reduce this inventory, MDOT SHA is keenly aware that bridges built in the 1950s and 1960s will soon need major rehabilitation. If the state waits until major rehabilitation is necessary, financial funding will likely be insufficient to meet the needs. Therefore, MDOT SHA aims to be proactive and perform preventive maintenance and preservation now to extend the life of the current inventory. For example, one program is performing latex-modified concrete bridge deck overlays. Many heavily traveled roads experience accelerated bridge deck deterioration because of the volume of truck traffic and the heavy use of deicing chlorides during the winter. MDOT SHA's typical practice is to remove a minimum of 2 in. of the existing deck. The first inch of removal can be done using mechanical methods such as grinding. Beyond that point, the removal is done with hydroblasting. Performing these deck overlays has extended the life of bridge decks by 15 to 20 years.

Another preservation program focuses on Maryland's historic structures, which provide insight and beauty from the past. Recent efforts on some challenging projects have proven that old concrete structures can be restored, or even upgraded, while maintaining their historic features. Recent successes include the restoration of two open-spandrel reinforced concrete arch bridges. On both projects, the concrete arches were restored while some of the secondary members were removed and replaced. To work on bridges of this type, traffic must be completely removed, and detailed analysis of construction staging and sequencing is needed to maintain balanced-loading conditions.

Conclusion

Maryland, like many states, has a large inventory of concrete bridges to maintain. Through years of observation, MDOT SHA has gained valuable insights about how these bridges perform, and these insights inform how it rehabilitates its bridges and what types of new structures are built. By sharing some of these insights, MDOT SHA hopes that it has helped others in the management of their bridges.

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A prestressed concrete solid slab being installed for the Maryland Route 36 bridge over Georges Creek. Solid slabs are the "go to" bridge type in Maryland for spans less than 55 ft. Photo: Maryland Department of Transportation State Highway Administration.

Bridge No. 01011 – Maryland Route 36 over Elk Lick Run. Photo: Maryland Department of Transportation State Highway Administration.